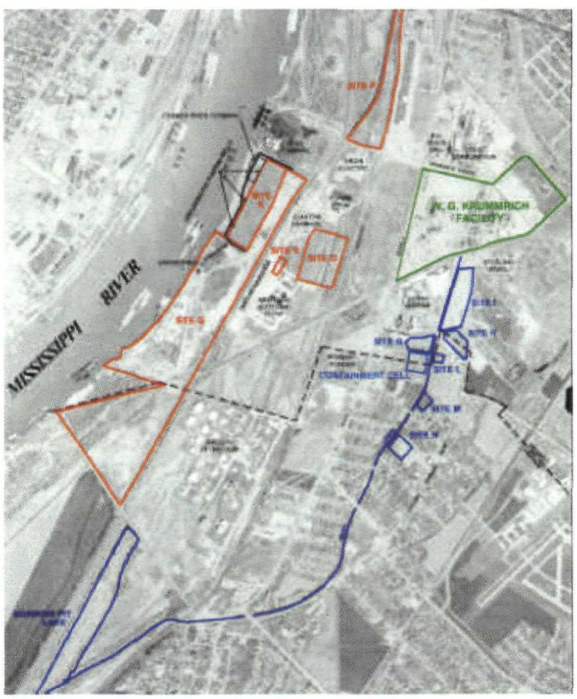
SAUGET AREA 2 GROUNDWATER MIGRATION CONTROL SYSTEM

Interim Operating Period 1
Tech Memo



Submitted to
USEPA, Chicago, Illinois

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Solutia, Inc.
St. Louis, Missouri

1.0 INTRODUCTION

Section 1.0 of this Interim Operating Period I Tech Memo describes the regulatory and operational history of the Sauget Area 2 Groundwater Migration Control System, which was installed to control the discharge of impacted groundwater to surface water downgradient of Sauget Area 2 Sites O, Q North, R and S; Sauget Area 1 Sites G, H, I and L; the southern portion of the W.G. Krummrich plant and other industries in the Sauget area. Section 2.0 presents the groundwater level, surface water level and pumping rate data obtained during the Interim Operating Period and Sections 3.0, 4.0 and 5.0 interpret these results. Section 6.0 proposes performance measures based on these results. Topics covered in each section are outlined below:

1.1 Focused Feasibility Study

On November 14, 2001, USEPA issued a Notification of Additional Work - Focused Feasibility Study, Groundwater Contamination near Site R, Sauget Area 2 Site - St. Clair County, Illinois under the provisions of Section V.2.5 of the November 24, 2000 Administrative Order by Consent (Docket No.V-W-'01-C-622) for the Sauget Area 2 Sites. In this notification, USEPA stated the following:

- **Historical groundwater data collected by Solutia in May 2000 indicates that contaminated groundwater discharges to the Mississippi River along at least a 2,000 foot length of the east bank adjacent to Site R;**
- **Contaminated groundwater discharging to the Mississippi River exceeds Illinois Environmental Protection Agency (IEPA) derived water quality criteria;**
- **Modeling predicts approximately 680,000 kg/year of SVOCs and VOCs are discharging to the river;**
- **Sediment samples collected by USEPA in October and November 2001 and analyzed for VOCs and SVOCs show that sediment is contaminated with significant contributions of VOCs and SVOCs starting at the northern edge of Site R. This area is also the approximate northern boundary of the groundwater contaminant plume;**
- **Significant concentrations of VOCs and SVOCs in sediment continue along and south of Site R, the approximate southern boundary of the groundwater contaminant plume;**
- **USEPA sediment data further documents exceedances of the IEPA derived water quality criteria; and**

- **Groundwater data at Site R correlates well with both the type and extent of contamination found in the Mississippi River sediment.**

USEPA also stated that:

> **"USEPA has determined that an immediate CERCLA response action is necessary to restrict the migration of the groundwater contamination and prevent an unacceptable discharge of contaminated groundwater to surface water in the vicinity of Site R. USEPA believes sufficient data currently exists to evaluate response actions to address the environmental concerns in connection with the groundwater contaminant plume at Site R.**
>
> **Pursuant to Section 2.5 - Additional Work of the November 24, 2000 Administrative Order on Consent for the Sauget Area 2 Site, USEPA has determined that additional work is necessary to prepare a focused feasibility study (FS) to address the known groundwater contamination problem in the vicinity of Site R. Within 45 days of receipt of this letter, Respondent(s) shall submit to USEPA for approval a draft focused FS for the Site R groundwater contamination problem that is consistent with the attached scope of work (SOW)."**

Solutia, the only party to carry out the additional work ordered on November 14, 2001, submitted the Sauget Area 2 Interim Groundwater Remedy Focused Feasibility Study on December 21, 2001 to address the discharge of impacted groundwater to surface water downgradient of Sauget Area 2 Sites O, Q North, R and S; Sauget Area 1 Sites G, H, I and L; the W.G. Krummrich plant and other industrial facilities in the Sauget area (Figure 1). The Focused Feasibility Study (FFS), revised in response to Agency comments and resubmitted on March 31, 2002, compared Groundwater Remedial Alternatives A (No Action), B (Physical Barrier) and C (Hydraulic Barrier) to identify the relative advantages and disadvantages of each alternative.

Both Remedial Alternative B (Physical Barrier) and Remedial Alternative C (Hydraulic Barrier) were designed to control groundwater discharging to the Mississippi River downgradient of Sauget Area 2 Sites O, Q North, R and S; Sauget Area 1 Sites G, H, I and L; the W.G. Krummrich plant and other industrial facilities in the Sauget area. Pumping rates for each alternative were linked to surface water levels in the Mississippi River because the river is the regional discharge point for the American Bottoms aquifer which underlies Sauget Area 1, Sauget Area 2 and the W.G. Krummrich facility and other industries in Sauget, Illinois. Because the Mississippi River is the regional discharge point for groundwater, surface water levels in the Mississippi River control groundwater gradients and groundwater gradients, in turn, control the amount of groundwater discharging to surface water.

Darcy's Law describes the relationship between groundwater discharge, aquifer hydraulic conductivity, groundwater gradient and groundwater discharge area as indicated below:

Q = KIA **Where:** **Q = Groundwater Discharge**
K = Aquifer Hydraulic Conductivity
I = Groundwater Gradient
A = Groundwater Discharge Area

Since hydraulic conductivity and discharge area are fixed values determined by site-specific aquifer hydraulic characteristics and hydrogeology, the variable determining the amount of groundwater discharge is groundwater gradient, i.e. the slope of the groundwater water surface. For a site

located adjacent to the Mississippi River, groundwater discharge to the river increases as surface water levels decrease and groundwater gradients toward the river increase. Using Darcy's Law, the groundwater discharge to the Mississippi River downgradient of Sauget Area 2 Site R varies with the gradient across Site R as follows:

Relationship Between Groundwater Gradient Across Sauget Area 2 Site R and Groundwater Discharge to Mississippi River

Groundwater Level Decrease Across Site R (Feet)	Groundwater Gradient Across Site R (Feet/Feet)	Groundwater Discharge Downgradient of Site R (Gallons per Minute)
0	0.00000	0
1	0.00143	423
2	0.00286	846
3	0.00429	1,270
4	0.00571	1,691
5	0.00714	2,115
6	0.00857	2,537

Notes: 1) **Hydraulic conductivity at Site R is 1E-10 cm/sec or 285 feet per day**
2) **Site R is 700 feet wide from upgradient to downgradient**
3) **Discharge area at the downgradient edge of Site R is 2000 feet wide and 100 feet thick**

Remedial Alternative B (Physical Barrier) was designed to abate the adverse impacts on the Mississippi River downgradient of Sauget Area 2 Site R by extracting groundwater discharging into a physical barrier constructed between Site R and the Mississippi River. Three groundwater extraction wells would be operated so that the groundwater gradients inside the barrier wall were the same as the groundwater gradients outside the barrier wall. As long as the gradients inside and outside the barrier wall were the same, groundwater was being pumped out of the barrier wall at the same rate as it entered, i.e. groundwater flow into the open end of the "U"-shaped barrier wall was equal to groundwater pumped out at its downstream end ($Q_{In} = Q_{Out}$). When $Q_{In} = Q_{Out}$, groundwater discharging to the Mississippi River downgradient of Site R would be under control.

Remedial Alterative C (Hydraulic Barrier) was designed to abate the impact of groundwater discharging to the Mississippi River downgradient of Sauget Area 2 Site R by creating a hydraulic trough between Site R and the Mississippi River. This groundwater migration control system was to be operated so that a continuous hydraulic trough existed between the downgradient boundary of Site R and the Mississippi River. Creation of a continuous hydraulic trough across the downgradient boundary of Site R would control the discharge of impacted groundwater from upgradient sources to the Mississippi River.

Remedial Alternative B pumping rates were determined by modeling the amount of groundwater that needed to be pumped from the upgradient side of the "U"-shaped barrier wall so that groundwater levels in piezometers immediately upgradient of the barrier wall had groundwater levels equal to surface water levels. Pumping to achieve groundwater levels inside the barrier wall equal to surface water levels

in the Mississippi River created a condition where flow into the barrier wall was equal to the amount of groundwater extracted from the barrier wall, i.e. $Q_{In} = Q_{Out}$. This was a conservative approach because Sauget Area 2 Site R is located 150 to 300 feet upgradient of the Mississippi River. As a result of this set back from the river, groundwater gradients from the upgradient side to the downgradient side of Site R are less than the groundwater gradients from the upgradient side of Site R to the Mississippi River when groundwater gradients are toward the river. By using the higher gradient between the upgradient side of Site R and the Mississippi River to determine pumping rates needed to achieve $Q_{In} = Q_{Out}$ for Remedial Alternative B (Physical Barrier), the FFS was conservative. This conservatism, while protective, resulted in pumping rates higher than those needed to control groundwater discharge to surface water downgradient of Sauget Area 2 Site R.

Pumping rates for Remedial Alternative C were determined using capture zone theory and the modeled pumping rates from Remedial Alternative B. Capture zone theory indicated that "no wall" pumping rates (Remedial Alternative C) needed to be twice the "wall" (Remedial Alternative B) pumping rates. That is why the "no wall" pumping rates given below are twice the "wall" pumping rates.

When in operation, pumping rates for Remedial Alternatives B (Physical Barrier) and C (Hydraulic Barrier) were to be determined using the "wall" and "no wall" look-up tables given below.

July 3, 2003 Sauget Area 2 Interim Groundwater Remedy Focused Feasibility Study and Final Design Pumping Rates

River Stage	Surface Water Elevation (feet, NGVD)	Physical Barrier "Wall" Pumping Rate (gpm)	Hydraulic Barrier "No Wall" Pumping Rate (gpm)
Top of Flood Wall	432	0	0
Highest Recorded	430	0	0
500 Year Flood	429	0	0
100 Year Flood	427	0	0
	413	0	0
	412	25	50
	411	50	100
	410	75	150
	409	100	200
	408	125	250
	407	150	300
	406	175	350
	405	200	400
	404	225	450
	403	250	500
	402	275	550
High Monthly Average	401	300	600
	400	325	650
	399	350	700
	398	375	750
	397	400	800
	396	425	850
	395	450	900
	394	475	950
	393	500	1000

	392	525	1050
Average Monthly Average	391	535	1070
	390	550	1100
	389	575	1150
	388	600	1200
	387	625	1250
	386	650	1300
	385	675	1350
	384	700	1400
Low Monthly Average	383	725	1450
	382	750	1500
	381	775	1550
Zero River Stage	380	800	1600
	379	825	1650
	378	850	1700
	377	875	1750
	376	900	1800
	375	925	1850
Lowest Recorded	374	950	1900

As originally envisioned in the March 31, 2002 Sauget Area 2 Interim Groundwater Remedy Focused Feasibility Study, physical barrier pumping rates were to be controlled by river stage using the "wall" look-up table. Water level information from a river stage gage installed in the Mississippi River downgradient of Site R was to be sent by telemetry to a pump controller that would adjust pumping rates so that $Q_{In} = Q_{Out}$. Groundwater level monitoring was to be done at the physical barrier to ensure acceptable performance of the physical barrier and to determine if gradient control was achieved. Gradient control was to be determined by comparing the water-level elevations in one pair of fully-penetrating water-level piezometers installed at the northwest corner of the physical barrier and one pair of piezometers installed at its southwest corner. One piezometer of each pair was to be installed inside the barrier wall and one was to be installed outside it. Pumping wells and water-level piezometers were to be located on the same north/south line. Pumping rates were to be adjusted so that the groundwater-level elevation in the inside piezometer at each corner of the barrier wall was the same as the groundwater-level elevation in the outside piezometer. This ensured that groundwater discharging into the physical barrier was controlled because groundwater gradients inside the barrier wall would match groundwater gradients outside the barrier wall.

Physical barrier pumping rates were not to be increased to the point where groundwater levels inside the barrier wall were lower than groundwater levels outside the barrier wall. Operating the physical barrier in this manner would effectively turn it into a large collection well that would have little or no effect on achieving short-term or long-term performance measures. However, it would potentially have a large adverse impact on the ability of the POTW to treat the increased flow from the hydraulic barrier. Treatment costs would also substantially increase without any corresponding increase in environmental protection.

In the June 13, 2002 Sauget Area 2 Interim Groundwater Remedy Focused Feasibility Study, two additional fully-penetrating water-level piezometers were added to the groundwater-level monitoring system (Figure 2). One pair of fully-penetrating water-level piezometers was to be installed halfway between the south pumping well and the center pumping well and another pair was to be installed halfway between the north pumping well and the center pumping well. One piezometer of each pair was to be installed on the downgradient side of the barrier wall and the other piezometer was to be installed on the upgradient side. The Agency added these two piezometer pairs because it was concerned about the effect of head build up on the stability of the physical barrier during periods of rapid change in surface water levels. However, USEPA Document EPA-540/2-84-001 (Slurry Trench Construction for Pollution Migration Control) recommends a soil/bentonite cutoff wall thickness of 0.5 to 0.75 feet for every 10 feet of hydrostatic head. On this basis, a 36-inch thick soil/bentonite barrier wall can resist hydrostatic heads of 40 to 60 feet. The highest head differential observed since completion of barrier wall construction in November 2004 is 15.5 feet:

Maximum Observed Gradient Across Barrier Wall After Completion of Construction in November 2004

Date		PZ - 1	PZ - 2	PZ - 3	PZ - 4
2004	November	-6.0	-7.4	-9.3	-4.6
	December	-5.1	-5.3	-4.9	-3.5
2005	January	-10.5	-15.5	-12.7	-8.1
	February	-5.4	-6.6	-6.2	-3.4

Note: Negative (inward) gradient indicates lower groundwater levels inside than outside the barrier wall

Consequently, these two additional piezometer pairs were not needed to maintain the integrity of the barrier wall. However, inclusion of these two piezometer pairs in the FFS had an unintended consequence. Their inclusion in the FFS, and subsequently in the Record of Decision, created a condition where performance of Remedial Alternative B (Physical Barrier) was not measured on the basis of gradients across Site R, i.e., $Q_{In} = Q_{Out}$, but rather was measured on the basis of zero or negative gradients across the barrier wall. The consequences of this change are discussed in Section 3.0 below.

1.2 Remedial Design/Interim Remedial Action

On September 30, 2002, USEPA issued a Unilateral Administrative Order (UAO) for Remedial Design and Interim Remedial Action (Docket No. V-W '02-C-716) under Section 106(a) of the Comprehensive Environmental Response, Compensation and Liability Act. The UAO required performance of a remedial design for the Sauget Area 2 Interim Groundwater Remedy as described in the September 30, 2002 Record of Decision (ROD) and also required implementation of the design. Solutia was the only company responsive to this Unilateral Administrative Order.

Remedial Alternative B (Physical Barrier) was selected by the ROD as the preferred remedy:

> **"to address the release of contaminated groundwater in the vicinity of Site R and the associated risks".**

The Sauget Area 2 Groundwater Migration Control System was designed to abate adverse impacts on the Mississippi River resulting from the discharge of groundwater from Sauget Area 2 Sites 0, Q North, R and S; Sauget Area 1 Sites G, H, I and L; the southern portion of the W. G. Krummrich Facility and other industries in the Sauget area (Figure 1). Solutia submitted the Pre-Final Design for the Sauget Area 2 Groundwater Migration Control System (SA2 GMCS) to USEPA on January 21, 2003 and the Final Design on July 3, 2003. The design basis for the Pre-Final and Final Designs was consistent with Focused Feasibility Study Remedial Alternative B (Physical Barrier), where the amount of groundwater extracted from the "U"-shaped barrier wall was to equal the amount of groundwater that flowed into it (i.e. $Q_{In} = Q_{Out}$), and the ROD requirement for installation of:

> **"three partially penetrating groundwater recovery wells capable of pumping a total of 303 to 724 gpm [that] will be installed inside the "U"-shaped barrier wall to abate groundwater moving into the wall".**

Pre-Final and Final Designs were designed to achieve the ROD requirement of $Q_{In} \approx Q_{Out}$, not the ROD requirement to achieve zero or negative gradients (inward flow) across the barrier wall.

Construction of the Sauget Area 2 Groundwater Migration Control System started in November 2002 was substantially complete in November 2004 when the last soil/bentonite backfill was placed in a 3,300 ft. long, 140 ft. deep, "U"-shaped slurry trench located between Sauget Area 2 Site R and the Mississippi River (Figures 1 and 2). Three groundwater extraction wells, each with a pumping capacity of approximately 700 gpm, were installed between the 1.4×10^{-8} cm/sec soil/bentonite barrier wall and Sauget Area 2 Site R to capture groundwater flowing into the upgradient end of the "U"-shaped barrier wall from Sauget Area 2 Sites O, Q North, R and S; Sauget Area 1 Sites G, H, I and L; the southern portion of the W. G. Krummrich Facility and other industries in the Sauget area (Figure 3).

Pumping from the Sauget Area 2 Groundwater Migration Control System (GMCS) started on July 12, 2003 at a flow rate restricted by the American Bottoms Regional Treatment Facility (ABRTF) to allow the POTW to acclimate to this discharge. On October 21, 2003, discharge restrictions were lifted by ABRTF and unrestricted discharge to the POTW was started the following day (October 22nd). Between October 22, 2003 and November 30, 2004, pumping rates were adjusted as summarized below:

Sauget Area 2 Groundwater Migration Control System Pumping Rate Basis, October 22, 2003 to November 30, 2004

Oct. 22, 2003	Nov. 24, 2003	GMCS pumping rate based on the July 3, 2003 Sauget Area 2 Interim Groundwater Remedy Focused Feasibility Study pumping rate look-up table for Alternative C - Hydraulic Barrier (No Wall) and the July 3, 2003 Sauget Area 2 Groundwater Migration Control System Design (Drawing No. 6-02). Total flow limited to 1800 gpm by ABRTF.
Nov. 25, 2003	Jan. 21, 2004	Extraction well pumping rates based on average groundwater level in two closest piezometers. Pumping rates adjusted to keep average groundwater level within +/- 0.5 ft. of surface water level. 1800 gpm maximum extraction rate restriction lifted by ABRTF on December 7.
Jan. 22, 2004	Feb. 4, 2004	Extraction system total flow rate adjusted to keep groundwater level in each piezometer within 0 to - 1 ft. of surface water level. Extraction well EW-2 pump failure due to sand abrasion on January 29th. System temporarily shut down to replace EW-2 on February 2 and 3, 2004.
Feb. 4, 2004	Mar. 4, 2004	Extraction system operated at maximum pumping capacity (2225 gpm) until EW-3 overheated and shut down on 2/17/04. EW-3 flow reduced by 50 gpm to prevent electrical overload and automatic pump shut down on 2/18/04
Mar. 5, 2004	Mar. 15, 2004	ABRTF restricted total extraction system flow to 500 gpm because of treatment system upset that resulted in a TSS excursion.
Mar. 16, 2004	Sep. 14, 2004	Extraction system total flow determined using no-wall look-up table.
Sep. 15, 2004	Oct. 10, 2004	Extraction system operated at maximum pumping rate as requested by USEPA.
Oct. 11, 2004	Nov. 30, 2004	Extraction system operated to keep groundwater level in inside piezometers less than or equal to surface water level in the Mississippi River.

1.3 Interim Operating Period

On November 30, 2004, USEPA, responding to Solutia's November 16, 2004 Sauget Area 2 Groundwater Migration Control System Status Report, proposed a 90 day Interim Operating Period starting on December 1, 2004. Surface water level, groundwater level and pumping rate data collected during this period would be used to determine if the Sauget Area 2 Groundwater Migration Control System could be operated as specified in the ROD, i.e. zero or negative (inward) gradient across the barrier wall as measured at piezometer pairs located at the northwest and southwest corners of the barrier wall and halfway between the center and northern and center and southern extraction wells (Figure 2). As discussed above, the ROD requirement adding piezometer pairs PZ-2 and PZ- 3 changed the focus of the Sauget Area 2 Groundwater Migration Control System from controlling the discharge of groundwater into the upgradient open end of the "U"-shaped barrier wall, as described in the Focused Feasibility Study, to controlling gradients across the barrier wall so that they were zero or negative (inward).

2.0 INTERIM OPERATING PERIOD RESULTS

The Interim Operating Period began on December 1, 2004 and finished on February 28, 2005. During this period, surface water levels in the Mississippi River, groundwater levels in piezometer pairs PZ-1, PZ-2, PZ-3 and PZ-4 and groundwater levels and discharge rates in extraction wells EW-1, 2 and 3 were measured and recorded. Data for December 2004 and January and February 2005 are given in Tables 1, 2 and 3, respectively. During this period, surface water levels in the Mississippi River ranged from a low of 382.25 ft NGVD to a high of 408.37 ft NGVD and discharge from the Sauget Area 2 Groundwater Migration Control System ranged from a high of 2174 gpm (maximum system capacity) to a low of 0 gpm, respectively.

2.1 Days with Negative (Inward) Gradients across the Barrier Wall

For 62 days during the 90 day Interim Operating Period (69 percent of the total period) gradients across the barrier wall were negative (i.e. groundwater levels were lower inside the barrier wall than outside) in all four water-level piezometer pairs (Table 4). In December 2004, negative (inward) gradients occurred on 22 out of 31 days while negative gradients were achieved in all piezometer pairs on 19 days in January 2005 and 21 days in February 2005 (Table 4).

Over these 62 days, inward gradients ranged from 0.00 to -15.48 and flow rates ranged from 0 to 1870 gpm (Table 4). Even with average monthly pumping rates as low as 383 to 757 gallons per minute, average monthly negative (inward) gradients across the barrier wall ranged from -1.25 feet to -6.29 feet:

Average Monthly Gradient for Days with Negative (Inward) Gradients Across the Barrier Wall

		Average Monthly Surface Water Level (Feet, NGVD)	Average Monthly Pumping Rate (GPM)	Average Monthly Negative (Inward) Gradients (Feet)			
				PZ - 1	PZ - 2	PZ - 3	PZ - 4
2004	December	392.71	757	-3.77	-1.95	-2.08	-1.84
2005	January	400.06	383	-5.22	-6.29	-5.60	-3.52
	February	396.41	658	-3.51	-1.83	-2.16	-1.25
	Average	396.39	599	-4.17	-3.36	-3.28	-2.20

Notes:
1) Negative (inward) gradient indicates lower groundwater levels inside than outside the barrier wall
2) Average monthly surface water level for days with negative gradients across barrier wall
3) Average monthly pumping rate for days with negative gradients across barrier wall
4) Average monthly negative (inward) gradients for days with negative gradients across the barrier wall

During the Interim Operating Period, average monthly negative gradients at PZ-1, 2, 3 and 4 were -4.17 feet, -3.36 feet, -3.28 feet and -2.20 feet, respectively.

Surface water levels varied between 387.32 and 408.37 ft. NGVD and averaged 396.39 ft. NGVD during days with negative gradients (Table 4). The surface water level high during these 62 days (408.37 ft. NGVD) was 10.57 feet higher than the surface water level high during days when gradients across the barrier wall were positive (397.80). A similar pattern was observed for surface water lows. For days with negative gradients, the surface water low elevation (387.32 ft NGVD) was 5.07 feet higher than the surface water low elevation for days with positive gradients (382.25 ft. NGVD). Average surface water levels for days with negative gradients were higher than the average monthly average Mississippi River stage (391 ft NGVD) while average surface water levels for days with positive gradients are lower:

Average Surface Water Levels for Days with Negative and Positive Gradients Compared to Mississippi River Stage

Mississippi River Monthly Average Stage		Date		Average Surface Water Level Days with Negative Gradients	Average Surface Water Level Days with Positive Gradients
High	401 ft NGVD				
		2005	January	400.06	
			February	396.41	
		2004	December	392.71	
Average	391 ft NGVD				
		2005	February		390.83
			January		390.05
		2004	December		383.81
Low	383 ft NGVD				

Based on these data, days with negative (inward) gradients across the barrier wall are associated with higher surface water levels than days with positive (outward) gradients. Gradients across the barrier wall were always negative when surface water level was equal to or greater than 393.80 ft NGVD.

Groundwater levels in piezometer pairs PZ-1, 2, 3 and 4 responded asymmetrically to surface water levels and pumping on days when gradients across the barrier wall were negative, surface water levels were high and pumping rates were low (Table 5):

Average Negative Gradients Across the Barrier Wall on Days with High Surface Levels and Low Pumping Rates

Average SWL (Feet NGVD)	Average Q (GPM)	Average Gradient Across Barrier Wall PZ - 1 (Feet)	PZ - 2 (Feet)	PZ - 3 (Feet)	PZ - 4 (Feet)	Delta (Feet)
400.94	17	-4.58	-4.94	-4.57	-2.79	2.15

Notes: 1) Negative (inward) gradient indicates lower groundwater levels inside than outside the barrier wall.
2) Days with minimum flow rates used to reduce pumping effects on piezometer response.

Piezometer pairs PZ-1, 2 and 3 respond in a similar fashion to high surface water levels and low pumping rates. However, the difference between the highest average negative (inward) gradient of -4.94 feet in PZ-2 and the lowest average negative gradient in PZ-4 is 2.15 feet. The inward gradient at PZ-4, located at the southwest corner of the barrier wall, is 1.91 feet lower than the average of the gradients at PZ-1, 2 and 3. These differences indicate that aquifer response to high surface water levels and low pumping rates is asymmetric.

2.2 Days with Positive (Outward) Gradients across the Barrier Wall

Groundwater gradients were positive (outward) across the barrier wall (groundwater levels inside the barrier wall were greater than groundwater levels outside the wall) on 28 of the 90 days (31 percent) in the Interim Operating Period (Table 6). On three of these days (February 2, 3 and 4, 2005), all of the extraction wells were turned off to allow installation of actuator valves. In December 2004, positive (outward) gradients occurred on 9 days while positive gradients were observed on 12 days in January 2005 and 7 days in February 2005 (Table 6). Positive gradients were only observed in piezometer pairs PZ-2 and PZ-3; gradients in PZ-1 and 4 were always negative except for February 2, 3 and 4, 2005).

During the 25 days when the extraction wells were in operation, positive gradients ranged from 0.15 to 2.09 feet with pumping rates ranging from 180 gpm to 2174 gpm, the maximum system capacity. PZ-2 was the only piezometer pair with a positive (outward) monthly average gradient during the three months of the Interim Operating Period:

Average Monthly Gradient for Days with Positive (Outward) Gradients Across the Barrier Wall

		Average Monthly Surface Water Level (Feet, NGVD)	Average Monthly Pumping Rate (GPM)	Average Monthly Positive (Outward) Gradients (Feet)			
				PZ - 1	PZ - 2	PZ - 3	PZ - 4
2004	December	383.81	2167	-3.89	0.98	-0.17	-1.50
2005	January	390.05	1229	-1.86	0.94	-0.94	-1.10
	February	390.83	1433	-3.22	0.07	-0.44	-0.73
	Average	388.23	1610	-2.99	0.66	-0.52	-1.11

Notes:
1) Positive (outward) gradient indicates lower groundwater levels inside than outside the barrier wall.
2) Average monthly surface water level for days with positive gradients across barrier wall.
3) Average monthly pumping rate for days with positive gradients across barrier wall.
4) Average monthly negative (inward) gradients for days with positive gradients across the barrier wall.

Average monthly gradients in PZ-1, 3 and 4 were negative (inward) for all three months of the Interim Operating Period.

Surface water levels varied between 382.25 and 397.80 ft. NGVD and averaged 388.23 ft. NGVD for days with positive gradients (Table 6). The surface water level high during these 28 days (397.80 ft.

NGVD) was 10.57 feet lower than the surface water level high during days when gradients across the barrier wall were negative (408.37). A similar pattern was observed for surface water lows, with surface water elevation low of 382.25 ft. NGVD for days with positive gradients 5.07 feet lower than the low surface water elevation for days with negative gradients (387.32 ft. NGVD). Average surface water level during days with positive gradients was 8.16 feet lower than for days with negative gradients (388.23 ft. NGVD vs. 396.39 ft. NGVD). Head across the barrier wall was always positive (outward) when surface water level was equal to or less than 385.14 feet. Based on these data, days with positive gradients are associated with lower surface water levels than days with negative gradients.

Groundwater gradients were outward (positive) at PZ-2 on 27 of the 28 days (96 percent) while gradients were positive on only 10 days (36 percent) in PZ-3 (Table 6). Gradients at PZ-1 and PZ-4 were always inward (negative) on the days when gradients were outward (positive) at PZ-2 and PZ-3 (Table 6). This pattern of gradients across the barrier wall, with negative gradients at the northwest and southwest corners and positive gradients in the center of its north/south alignment, provides further evidence of the aquifer's asymmetric response to surface water levels and pumping.

Groundwater levels in piezometer pairs PZ-1, 2, 3 and 4 responded asymmetrically to surface water levels and pumping on days when gradients across the barrier wall were positive, surface water levels were low and pumping rates were high (Table 5):

Average Gradients Across the Barrier Wall on Days with Low Surface Water Levels and High Pumping Rates

Average SWL (Feet NGVD)	Average Q (GPM)	Average Gradient Across Barrier Wall PZ - 1 (Feet)	PZ - 2 (Feet)	PZ - 3 (Feet)	PZ - 4 (Feet)	Delta (Feet)
383.60	2166	-3.87	1.01	-0.15	-1.48	4.88

Notes: 1) Negative (inward) gradient indicates lower groundwater levels inside than outside the barrier wall.
2) Days with minimum flow rates used to reduce pumping effects on piezometer response.

None of the piezometer pairs responded in a similar manner and the difference between the highest and lowest average gradient (4.88 feet) is more than two times the difference observed for days with negative gradients and minimum flow rates (2.15 feet). The inward gradient is highest at PZ-1, located at the northwest corner of the barrier wall and lowest at PZ-3 which is located halfway between EW-2 and 3. PZ-2 had a positive head on all eleven days with low surface water levels and high pumping rates while PZ-3 only had a positive head on four of these days. PZ-1 and PZ-4 had negative (inward) gradients on all eleven of days. These differences indicate that aquifer response to low surface water levels and high pumping rates is asymmetric.

On eleven of the 27 days (41 percent) when positive (outward) gradients were observed in PZ-2, the Sauget Area 2 Groundwater Migration System was pumping at maximum capacity:

Outward (Positive) Groundwater Gradients Across Barrier Wall During Maximum Pumping Rate Conditions

Date			SWL (Feet NGVD)		PZ-1 (Feet)	PZ-2 (Feet)	PZ-3 (Feet)	PZ-4 (Feet)	Total Q (gpm)
2004	December	23	Monthly High	385.08	-4.08	0.62	-0.45	-1.76	2164
		24		383.40	-3.41	1.80	0.54	-1.16	2174
		25		383.65	-3.55	1.58	0.31	-1.22	2171
		26		384.12	-4.05	0.72	-0.37	-1.62	2169
		27		383.99	-4.09	0.72	-0.40	-1.59	2170
		28		384.06	-4.10	0.60	-0.50	-1.66	2170
		29		383.70	-4.00	0.80	-0.40	-1.60	2163
		30		383.53	-4.00	0.77	-0.37	-1.60	2162
		31	Monthly Low	382.70	-3.71	1.25	0.11	-1.33	2161
2005	January	1		383.08	-4.02	0.85	-0.30	-1.55	2162
		2	Monthly Low	382.25	-3.61	1.44	0.22	-1.22	2160
			Average	383.60	-3.87	1.01	-0.15	-1.48	2166

Pumping at full system capacity was unable to produce a zero or negative (inward) gradient at each of the four piezometer pairs during this eleven day period with low surface water levels. Aquifer responses to pumping during this period were asymmetrical with an average gradient of -3.87 ft at PZ-1, 1.01 at PZ-2, - 0.15 at PZ-3 and -1.48 at PZ-4. The aquifer response to pumping was greatest at the northwest and southwest corners of the barrier wall (PZ-1 and PZ-4) and the least at the two piezometer clusters located half way between the extraction wells (PZ- 2 and PZ-3). PZ-2 showed the least response to pumping at maximum system capacity.

3.0 EFFECT OF NEGATIVE GRADIENTS ACROSS BARRIER WALL ON PUMPING RATES

When the Sauget Area Groundwater Migration Control System is operated with negative (inward) gradients across the barrier wall, the "U"-shaped barrier wall becomes a large collection well. Section 5.2 of the July 3, 2003 Sauget Area 2 Interim Groundwater Remedy Amended Focused Feasibility Study explicitly stated that it was not appropriate to operate the system in this manner:

> **"Physical barrier pumping rates will not be increased to the point where water levels inside the barrier wall are lower than water levels outside the barrier wall. Operating the physical barrier in this manner effectively turns it into a large collection well that will have little or no effect on achieving short-term or long-term performance measures. However, it will potentially have a large adverse impact on the ability of the POTW to treat the increase flow from the hydraulic barrier. Treatment costs will also substantially increase without any corresponding increase in environmental protection.**
>
> **In order to evaluate the impact of maintaining a small inward gradient, additional modeling was carried out to determine the increase in groundwater extraction rate that would be required to maintain 2, 4, and 6 inch inward heads across the wall. These analyses indicate that the groundwater extraction rate for average river level would have to be increased by almost 60 percent (to 842 gpm from 535 gpm) in order to maintain a 2 inch inward head differential. Extraction rates would have to increase to 882 gpm and 992 gpm to maintain inward head differentials of 4 and 6 inches respectively. Increasing the average pumping rate to 842 gpm to maintain a 2 inch inward head differential will result in an increase of approximately $810,000 in the annual operating cost of the system. The increase in annual operating costs to maintain a 6 inch head differential is approximately $1,300,000.**

> **Recognizing that the extraction system is designed to remove the same volume of groundwater as the steady state flow into the barrier wall, it is reasonable to expect that any head imbalance across the wall will be very small and will be localized. Given that the hydraulic conductivity of the barrier wall is expected to be in the range of $1x10^{-6}$ to $1x10^{-7}$ cm/sec, seepage through the wall resulting from such small localized gradients will be minor. Consequently, it is not considered appropriate to expend large annual sums to reduce the potential that unobserved outward gradients might occur at locations between monitoring points."**

Attachment 2 provides the basis for estimating the effect of negative gradients on system pumping rates.

Currently, the system is being operated to achieve a zero gradient across the barrier wall at piezometer pairs PZ-1, PZ-2, PZ-3 and PZ-4. Because the aquifer responds asymmetrically to pumping, large negative (inward) gradients develop in PZ-1 and PZ-4 when the system tries to achieve zero or negative gradients at PZ-2 and PZ-3. As described above, the Sauget Area 2 Groundwater Migration Control System was unable to develop a zero or negative (inward) gradient at all four piezometer pair locations on 28 days during the Interim Operating Period, which was 31 percent of the total time period.

While the Sauget Area 2 Groundwater Migration Control System was unable to maintain negative (inward) gradients across the barrier wall on 9 days in December 2004, 12 days in January 2005 and 7 days in February 2005, the monthly average gradient across the barrier wall was negative at each piezometer pair during the Interim Operating Period. Monthly average gradients for each piezometer pair are included in Tables 1, 2 and 3 and summarized below:

Monthly Average Gradient Across the Barrier Wall Between Piezometer Pairs During the Interim Operating Period

Date		PZ - 1	PZ - 2	PZ - 3	PZ - 4	Average
2004	December	-3.80	-1.10	-1.53	-1.74	-2.04
2005	January	-3.89	-3.20	-3.72	-2.79	-3.40
	February	-3.12	-0.98	-1.62	-0.88	-1.65
	Average	-3.60	-1.76	-2.29	-1.80	-2.36

All of the monthly average gradients were negative (inward) and ranged from -0.88 to -3.89 feet and the average monthly average gradient (-2.36 feet) was negative (inward).

With the exception of one day in January (January 18, 2005, when extraction well total flow was 180 gpm) and three days in February (February 2, 3 and 4, 2005, when the extraction wells were partially off or completely off to install actuator valves on each pumping well), average daily and weekly gradients across the barrier wall were negative (inward) throughout the Interim Operating Period (Table 7):

Daily and Weekly Average Gradients Across the Barrier Wall during the Interim Operating Period

	December 2004		January 2005		February 2005	
Day	Daily	Weekly	Daily	Weekly	Daily	Weekly
1	-3.21		-1.26		-0.96	
2	-2.97		-0.79	-1.02	0.79 [2]	
3	-2.62		-0.14		3.01 [2]	
4	-2.26		-3.27		1.59 [2]	

5	-1.53	-2.52	-7.48		-1.12	
6	-2.24		-11.64		-1.26	0.34
7	-3.59		-11.37		-1.34	
8	-4.67		-8.23		-1.38	
9	-3.97		-6.14	-6.89	-1.37	
10	-3.27		-4.77		-1.41	
11	-2.15		-3.35		-1.38	
12	-1.65	-3.08	-3.31		-1.38	
13	-1.90		-5.02		-1.40	-1.38
14	-1.69		-7.11		-2.23	
15	-1.55		-6.63		-4.29	
16	-2.32		-4.30	-5.03	-5.40	
17	-1.36		-2.66		-4.98	
18	-1.81		0.19 [3]		-4.07	
19	-2.07	-1.82	-1.12		-3.36	
20	-2.27		-1.78		-2.41	-3.82
21	-2.09		-3.44		-1.63	
22	-1.82		-1.72		-0.99	
23	-1.42		-1.20	-1.42	-1.41	
24	-0.56		-1.08		-1.30	
25	-0.72		-1.16		-1.27	
26	-1.33	-1.46	-1.21		-1.31	
27	-1.34		-0.86		-1.32	-1.32
28	-1.42		-0.66		-1.30	-1.30
29	-1.30		-0.66			
30	-1.30		-0.65	-0.90		
31	-0.92	-1.26	-0.61	-0.61		
Average	-2.04	-2.03	-3.34	-2.65	-1.59	-1.50

Notes: 1) **Shaded numbers indicate positive (outward) gradients across barrier wall.**
2) **Days with pumps partially or completely off to install actuator valves on extraction wells.**
3) **Day with low pumping rate (180 gpm).**

These data indicate that the Sauget Area 2 Groundwater Migration Control System was operated so that flow into the barrier wall was less than flow out of the barrier wall ($Q_{In} < Q_{Out}$) on a daily, weekly and monthly basis during the Interim Operating Period. Operating the Sauget Area 2 Groundwater Migration Control System so that $Q_{In} < Q_{Out}$ converts the barrier wall into a large collection well, which is not consistent with the FFS, ROD and the Pre-Final and Final Designs nor is it necessary to protect public health and the environment. The system was conceived and designed to operate so that $Q_{In} = Q_{Out}$. Operating the system during the Interim Operating Period to achieve zero or negative (inward) gradients across the barrier wall ($Q_{In} < Q_{Out}$) required more pumping than needed to achieve the FFS, ROD and Pre-Final and Final Design goal of $Q_{In} = Q_{Out}$.

Additional evidence that the Sauget Area 2 Groundwater Migration Control System was operated in a manner inconsistent with the FFS, ROD and Pre-Final and Final Designs is the fact that annualized groundwater treatment costs are on the order of $3MM to 3.5MM, assuming an average treatment cost of $5.00 per thousand gallons, which is more than twice the expected cost of $1.4MM. If the increased cost expected for a 6-inch inward gradient ($1.3MM) is added to the expected annual cost for operating the barrier wall so that $Q_{In} = Q_{Out}$ ($1.4MM), the total annual treatment cost is $2.7MM. Actual annual treatment costs of $3MM to $3.5MM indicate the Sauget Area 2 Groundwater Migration Control System is being operated with a net inward (negative) gradient of greater than 6-inches.

Any negative inward gradient across the barrier wall ($Q_{In} < Q_{Out}$) increases pumping rates and treatment costs without providing additional protection of public health or the environment. For example, negative (inward) gradients as low as to 2 to 4 inches increase annual treatment costs by $0.8MM and $0.9MM, respectively, assuming an average treatment cost of $5.00 per thousand gallons (Attachment 2).

To further illustrate the effect of negative (inward) gradients across the barrier wall, Visual Modflow was used to simulate the effects of negative gradients on pumping rates from a 3300 ft. long, "U"-shaped barrier wall constructed in an isotropic aquifer 100 feet thick with the same hydraulic characteristics as the aquifer found at Sauget Area 2 (Attachment 3). Inward (negative) gradients of -1, -2, -3 and -4 feet across the barrier wall were modeled for an aquifer condition with a groundwater gradient of 6 feet from the open upgradient end to the closed downgradient end of the barrier wall, which is the maximum gradient observed across Site R during low river stage conditions (Attachment 4). Achieving inward gradients of -1 to -4 feet across the barrier wall under these conditions required increasing the groundwater extraction rates by a factor of 1.67 to 1.99 over the pumping rate that achieved control of the groundwater entering the barrier wall (i.e. $Q_{In} = Q_{Out}$):

Pumping Rates Required to Achieve Negative (Inward) Gradients Across Barrier Wall at Low River Stage

Negative Gradient Across Barrier Wall (Feet)	Extraction System Pumping Rate (GPM)	Percent of $Q_{In} = Q_{Out}$ Flow Rate (%)
0	1635	100
- 1	2733	167
- 2	2910	178
- 3	3084	189
- 4	3258	199

Notes: 1) Average monthly negative (inward) gradients across the barrier wall ranged from a low of - 0.88 feet to a high of - 3.89 feet during the Interim Operating Period.

Operating the Sauget Area 2 Migration Control System so that it creates a negative gradient across the barrier wall ($Q_{In} < Q_{Out}$) results in substantial increases in pumping rates compared to operating the system so that $Q_{In} = Q_{Out}$. These increases in pumping rates do not increase protection of public health and the environment. However, they do substantially increase the cost of operating the system (Table 8). Operating the Sauget Area 2 Groundwater Migration System so that $Q_{In} < Q_{Out}$ (negative inward gradient across the barrier wall) during the Interim Operating period increased total groundwater pumpage by more than 54,000,000 gallons and increased treatment costs by more than $270,000:

Estimated Costs to Achieve Negative (Inward) Gradients Across Barrier Wall During Interim Operating Period

Date		Flow Out - Flow In (Gallons)	Treatment Cost ($)
2004	December	26,262,535	161,252 [1]
2005	January	11,303,266	109,529 [2]
	February	16,783,407	235,471 [3]
	Total	54,349,208 gallons	$ 506,252

Notes:
1) December 2004 treatment charges were $322,000 for 52,483,000 gallons ($6.14/1000 gallons).
2) January 2005 treatment charges were $324,000 for 33,449,000 gallons ($9.69/1000 gallons).
3) February 2005 treatment charges were $420,000 for 29,960,000 gallons ($14.03/1000 gallons).
4) Average treatment charge was $9.20 per thousand gallons during the Interim Operating Period.

On an annualized basis, operating the system so that $Q_{In} < Q_{Out}$ will increase pumpage by more than 217,000,000 gallons and increase treatment costs by more than $2,000,000. Consequently, the system is not cost-effective when operated with a negative gradient across the barrier wall. In addition, operating the system in this manner is not consistent with the FFS, ROD and Pre-Final and Final Designs.

Modeling also indicates the optimum pumping rate for a barrier wall, in which all of the flow entering the wall is pumped out ($Q_{In} = Q_{Out}$), occurs over a narrow range of pumping rates. Attachment 5 includes modeled flow lines for a "U"-shaped barrier wall with groundwater gradients of 1, 2, 3, 4, 5 and 6 feet from the open upgradient end of the "U" to its downgradient closed end. Gradients of 1, 2, 3, 4 5 and 6 feet were evaluated because groundwater decreases from the open end to the closed end of the Sauget Area 2 Groundwater Migration Control System span this range when groundwater is discharging to surface water (Attachment 4). Pumping rates that result in flow lines converging into the "U"-shaped barrier wall ($Q_{In} < Q_{Out}$), flowing straight into the barrier wall ($Q_{In} = Q_{Out}$) and diverging from the barrier wall ($Q_{In} > Q_{Out}$) are summarized below:

Pumping Rated that Result in Convergent, Parallel and Divergent Flow Lines into a "U"-Shaped Barrier Wall

Gradient Across Site (Feet)	Pumping Rate Where Flow Lines Converge (GPM)	Pumping Rate Where Flow Lines Parallel (GPM)	Pumping Rate Where Flow Lines Diverge (GPM)	Converge/Diverge Delta (GPM)
6	1735	1635	1535	200
5	1483	1383	1283	200
4	1209	1119	1029	200
3	1086	996	906	186
2	588	543	498	90
1	295	265	235	60

Conditions where groundwater flow lines converge ($Q_{In} < Q_{Out}$) and diverge ($Q_{In} > Q_{Out}$) can easily occur if flow rates are not carefully controlled. Under pumping ($Q_{In} > Q_{Out}$) results in a condition where groundwater flow lines diverge from the "U"-shaped barrier wall. Over pumping ($Q_{In} < Q_{Out}$)

results in a condition where more water is pumped than is needed to capture the groundwater entering the barrier wall, i.e. groundwater flow lines converge into the "U"-shaped barrier wall. Operating in a condition where flow lines converge into the barrier wall does not increase protection of public health and the environment. However, it does reduce the cost-effectiveness of the groundwater migration control system because of increased treatment costs. In addition, this mode of operation is not consistent with the mode of operation included in the July 3, 2003 Sauget Area 2 Interim Groundwater Remedy Amended Focused Feasibility Study, specifically:

> **"Physical barrier pumping rates will not be increased to the point where water levels inside the barrier wall are lower than water levels outside the barrier wall."**

To be consistent with the FFS, ROD and Pre-Final and Final Designs, the Sauget Area 2 Groundwater Migration Control System needs to be operated so that groundwater flow into the "U"-shaped barrier wall is equal to the amount of groundwater extracted, i.e. $Q_{In} = Q_{Out}$. This goal can be achieved without operating the system to produce a negative gradient across the barrier wall.

4.0 EFFECT OF POSITIVE GRADIENTS ACROSS BARRIER WALL ON GROUNDWATER DISCHARGE TO MISSISSIPPI RIVER

Positive (outward) gradients across the barrier wall (groundwater levels higher on the upgradient side than on the downgradient side of the barrier wall) were observed on 28 days during the Interim Operating Period (Table 6). On 27 of these 28 days, the gradients at piezometer pair PZ-2 were positive and ranged from 0.10 to 4.93 feet. The longest period of continuous positive gradients at PZ-2 was the 14 days from January 24 to February 6, 2005. During this period, positive (outward) gradients ranged from 0.10 to 4.93 feet. A 12 day period of positive gradients occurred between December 23, 2004 and January 3, 2005, with outward gradients of 0.60 to 1.80 feet.

Positive (outward) gradients of this magnitude on the upgradient side of the barrier wall will not result in an increase in mass flux on the downgradient side of the barrier wall because the three ft. thick, 1.4×10^{-8} cm/sec soil/bentonite backfill in the barrier wall effectively retards movement through the wall. It would take 124 years for 0.3 gpm to seep through the barrier wall if a 1 foot positive gradient was maintained on the upgradient side of the barrier wall throughout this entire period (Attachment 6). If a 5 foot head were maintained on the upgradient side of the barrier wall, 0.16 gpm would flow through the wall after 25 years.

The net distance that a water or contaminant particle could penetrate into the barrier wall during the 27 days of positive (outward) gradients at piezometer pair PZ-2 is calculated to be 0.0011 feet or 0.04 percent of the total barrier wall thickness (Attachment 6). This hypothetical penetration assumes linear

flow from the inside to outside piezometer, a worst-case assumption because the easiest flow path for a particle is toward the nearest extraction well and not through the barrier wall (as discussed below).

Given this resistance to flow through the wall, positive (outward) gradients with durations of days, months and even years will not result in groundwater flow through the barrier wall due to its low hydraulic conductivity of 1.4 x 10^{-8} cm/sec and the gradients created by pumping wells on the upgradient side of the barrier wall.

Further analysis indicates that particles released on the upgradient side of the barrier wall are not likely to move through the barrier wall even though there is a positive head on the upgradient side of the wall (Attachment 8). Particle flow direction is based on the resultant vector of flow direction, hydraulic gradient and hydraulic conductivity. Because the flow vector through the wall has a very low hydraulic conductivity ($1.4x10^{-8}$ cm/sec), the vector through the wall will be orders of magnitude smaller than the flow vector towards a pumping well. Therefore, a positive head of 1 ft from the inside to the outside piezometers at PZ-2 (a gradient of about 1 ft over 40 ft, or 0.025 ft) creates a flow vector equivalent to only $3.6x10^{-4}$ ft/yr through the wall to the west:

$$V_d = \left(1.4x10^{-8}\frac{cm}{\sec}\right)\cdot\left(\frac{1ft}{40ft}\right)\cdot\left(86400\frac{\sec}{day}\right)\cdot\left(365\frac{day}{year}\right)\left(\frac{ft}{30.5cm}\right) \text{ to the west}$$

$$V_d = 0.00036 ft/yr \text{ to the west (270 degrees)}$$

A 0.01 ft gradient from the PZ-2 Inside piezometer towards the pumping well EW-2 over a 40 ft distance is a much stronger vector, however, with a value of 26 ft/yr to the northeast (35,000 times higher):

$$V_d = \left(1.0x10^{-1}\frac{cm}{\sec}\right)\cdot\left(\frac{0.01ft}{40ft}\right)\cdot\left(86400\frac{\sec}{day}\right)\cdot\left(365\frac{day}{year}\right)\left(\frac{ft}{30.5cm}\right) \text{ to the southeast}$$

$$V_d = 25.8 ft/yr \text{ to the southeast (66 degrees)}$$

The resultant vector (Freeze and Cherry, 1979, Groundwater, pp. 32 to 35 and http://hyperphysics.phy-astr.gsu.edu/hbase/vect.html;) would then be:

$V_d = 25.8\ ft/yr$ to the southeast (65.99967 degrees)

Therefore, even with a very slight gradient towards the pumping, well (even a gradient below the measurement resolution of 0.01 ft over 40 ft) will overwhelm any flow vector out through the low-permeability barrier wall. In other words, particles located at the inside piezometer will move

toward the nearest pumping well under the slightest gradient towards the pumping well, even if there is a positive (outward) gradient between the inside and outside piezometers.

This result is verified with the MODFLOW model of the actual site. As shown in Attachment 7, an apparent outward gradient (based on the two piezometer pairs at PZ-2) does not result in particles migrating through the wall. Instead, the resultant vector of flow (as calculated by MODFLOW) from the inside piezometer is toward the pumping well.

5.0 EFFECT OF BARRIER WALL ON DOWNGRADIENT GROUNDWATER LEVELS

Groundwater levels in PZ-2 Outside and PZ-3 Outside are below surface water levels on all but one day (January 23, 2005) of the Interim Operating Period (Table 9). Monthly maximum, average and minimum difference between groundwater levels in these piezometers and surface water levels in the Mississippi River are given below:

Monthly Average, Maximum and Minimum Differences between GWL in PZ-2 Outside, 3 Outside and Surface Water Level

Date		PZ-2 Outside			PZ-3 Outside		
		Maximum (Feet)	Average (Feet)	Minimum (Feet)	Maximum (Feet)	Average (Feet)	Minimum (Feet)
2004	December	-1.69	-0.98	-0.37	-2.63	-1.34	-0.45
2005	January	-2.61	-1.46	0.18	-4.59	-1.96	0.28
	February	-2.07	-1.36	-0.81	-3.20	-1.41	-0.38
	Average	-2.12	-1.27	-0.33	-3.47	-1.57	-0.81

Since the Mississippi River is the regional discharge point for the American Bottoms aquifer, it is unusual to have groundwater levels lower than surface water levels immediately adjacent to the river. This condition is most likely result of the "shadow" effect of the barrier wall. When groundwater flows along the outside edges of the "U"-shaped barrier wall, flow lines will converge as they move past the downgradient edge of the wall (Attachment5). As the flow lines "wrap" around the northwest and southwest corners of the barrier wall, the equipotential lines move up gradient in order to create a gradient that results in flow to the river (Attachment 8). Modeling indicates that groundwater levels on the downgradient side of the barrier wall will be depressed from -0.5 to -3 feet when gradients from the upgradient end of the barrier wall to its downgradient end are 1 and 6 feet, respectively. These modeled water-level depressions (-0.5 to -3 feet) span the range of observed monthly average water-level depressions (-0.88 to -3.89 feet) on the downgradient side of the barrier wall providing evidence that the observed depressions are due to groundwater flow around the downgradient end of the barrier wall.

6.0 PERFORMANCE MEASURES

6.1 Current Performance Measures

Focused Feasibility Study "Wall" Look-Up Table - As described in the Focused Feasibility Study, Record of Decision and Pre-Final and Final Designs, the Sauget Area 2 Groundwater Migration Control System was evaluated, selected and designed to abate the impact of groundwater discharging to surface water. The Focused Feasibility Study included a look-up table that linked pumping rates from the three extraction wells installed on the upgradient side of the barrier wall to surface water levels in the Mississippi River. This look-up table, based on MODFLOW groundwater modeling, was to be used to control pumping rates so that groundwater flow into the barrier wall was equal to the amount of groundwater pumped out of the barrier wall, i.e. $Q_{In} = Q_{Out}$. Groundwater levels in two piezometer pairs (PZ-1 and PZ-4) were to be used to adjust pumping rates so that positive (outward) heads did not develop on the upgradient side of the barrier wall. Transient positive heads on the upgradient side of the barrier wall during rapid declines in surface water levels were thought to have the potential to adversely affect the stability of the barrier wall. Sustained positive heads on the upgradient side of the barrier wall were to create the potential for migration through the barrier wall.

Data collected during the Interim Operating Period demonstrated that the Remedial Alternative B - Physical Barrier ("wall") look-up table included in the FFS was not an appropriate performance measure. The "wall" look-up table over-predicted pumping rates by 300 percent during periods of high monthly average surface water levels (401 ft. NGVD) and under-predicted pumping rates by 191 percent during periods of low monthly average surface water levels (383 ft NGVD) in the Mississippi River (Table 10). Predicted pumping rates only matched Darcy flow into the barrier wall during average monthly average (391 ft NGVD) surface water levels in the Mississippi River:

Pumping Rates and Groundwater Gradients during High, Average and Low Monthly Average Mississippi River Stages

Monthly Average River Stage (Feet NGVD)		Average Surface Water Level (Feet NGVD)	Groundwater Flow Into Barrier Wall				Gradient Across Barrier Wall				
			MODFLOW (gpm)	Darcy (gpm)	Average Actual (gpm)	Actual vs. Darcy (gpm)	PZ - 1 (feet)	PZ - 2 (feet)	PZ - 3 (feet)	PZ - 4 (feet)	Average (feet)
High	401	401.13	300	0	65	+65	-5.04	-5.58	-4.82	-3.06	-4.62
Average	391	391.37	535	595	1073	+478	-2.70	-0.18	-1.17	-1.03	-1.27
Low	383	383.29	725	1388	2166	+778	-3.80	1.15	-0.04	-1.41	-1.03

Notes: 1) Data for days during the Interim Operating Period with average surface water levels within +/- 1 ft. of high, average and low monthly average river stages in the Mississippi River.

Zero or Negative (Inward) Gradient across Barrier Wall - During preparation of the Focused Feasibility Study, two additional piezometer pairs were added to the groundwater-level measurement system; one between the north and central extraction wells and one between the central and south extraction wells.

An unintended consequence of adding these two piezometer pairs was to change the focus of the Sauget Area 2 Groundwater Migration Control System from controlling groundwater flow into the barrier wall based on groundwater gradients across Site R to controlling groundwater flow based on groundwater gradients across the barrier wall, i.e. zero or negative gradients across the barrier wall in all four piezometer pairs.

Surface water level, groundwater level and pumping rate data collected during the Interim Operating Period demonstrated that the Sauget Area 2 Groundwater Migration Control System could not be operated to meet the ROD performance measure of zero or negative (inward) gradients across the barrier wall ($Q_{In} < Q_{Out}$) at piezometer pairs PZ-1, 2, 3 and 4. This performance measure was not achieved on 28 of the 90 days (31 percent) of the Interim Operating Period. Compared to operating the Sauget Area 2 Groundwater Migration Control System so that $Q_{In} < Q_{Out}$, which is consistent with the FFS, ROD and Pre-Final and Final Designs, operating to achieve zero or negative (inward) gradients across the barrier wall ($Q_{In} < Q_{Out}$) during the Interim Operating Period resulted in an increased groundwater discharge of more than 54,000,000 gallons to the POTW (0.6 MGD) and increased treatment costs by more the $270,000 without any corresponding increase in protection of public health and the environment (Table 8).

Data collected during the Interim Operating Period indicate that, for a number of reasons, gradient across the barrier wall is not a good performance measure for a system designed to:

> **"address the release of contaminated groundwater in the vicinity of Site R and the associated risks ... [by installing] three partially penetrating groundwater recovery wells capable of pumping a total of 303 to 724 gpm ... [that] will be installed inside the "U"-shaped barrier wall to abate groundwater moving into the wall".**

First, piezometer pairs PZ-1, 2, 3 and 4 measure gradient across the barrier wall and not gradient across Site R. Gradient across the barrier wall is not a good performance measure because gradient across Site R controls groundwater flow into the barrier wall. Gradient across the barrier wall correlates poorly with pumping rates during the Interim Operating Period as is summarized below and demonstrated in Table 11:

Comparison of Average Gradient Across Barrier Wall to Actual Pumping Rate during Interim Operating Period

Week Number	Week Ending	Gradient vs. Pumping Rate Correlation Coefficient	Week Number	Week Ending	Gradient vs. Pumping Rate Correlation Coefficient
1	5 - Dec-04	1.00	7	16-Jan-05	0.59
2	12-Dec-04	0.31	8	23-Jan-05	-0.26
3	19-Dec-04	-0.48	9	30-Jan-05	0.93
4	26-Dec-04	0.88	10	6-Feb-05	-0.94
5	2-Jan-05	0.71	11	13-Feb-05	0.75
6	9-Jan-05	0.76	12	20-Feb-05	0.66

Second, groundwater levels in piezometer pairs PZ-1, 2, 3 and 4 do not respond uniformly to changes in surface water level and pumping rates. For high surface water level and low pumping rate conditions, piezometer pairs PZ-1, 2 and 3 respond in a similar fashion. However, the inward gradient at PZ-4, located at the southwest corner of the barrier wall, is 1.91 feet lower than the average of the gradients at PZ-1, 2 and 3. During low surface water and high pumping rate conditions, none of the piezometer pairs responded in a similar manner. The inward gradient was highest at PZ-1, located at the northwest corner of the barrier wall and lowest at PZ-3 which is located halfway between EW-2 and 3. PZ-2 had a positive head on all eleven days with low surface water levels and high pumping rates while PZ-3 only had a positive head on four of these days. PZ-1 and PZ-4 had negative (inward) gradients on all eleven of days. These differences indicate that groundwater gradients across the barrier wall respond asymmetrically to surface water levels and pumping rates.

Third, modeling indicates that groundwater levels on the downgradient side of the barrier wall will be depressed from -0.5 to -3 feet when gradients from the upgradient end of the barrier wall to its downgradient end are 1 and 6 feet, respectively. These modeled water-level depressions (-0.5 to -3 feet) span the range of observed monthly average water-level depressions (-0.88 to -3.89 feet) on the downgradient side of the barrier wall providing evidence that the observed depressions are due to groundwater flow around the downgradient end of the barrier wall. This "shadow" effect of the barrier wall occurs when groundwater flow lines along the outside edges of the "U"-shaped barrier wall converge as the move past the downgradient edge of the wall. As the flow lines "wrap" around the northwest and southwest corners of the barrier wall, the equipotential lines move up gradient in order to create a gradient that results in flow to the river. Consequently, groundwater levels in PZ-2 Outside and PZ-3 Outside are lowered by groundwater flow patterns created by the barrier wall and can not be reliably used to control operation of the Sauget Area 2 Groundwater Migration Control System.

Fourth, flow through the barrier wall did not occur on the 28 days when groundwater gradients across the wall were positive, i.e. groundwater levels were higher on the upgradient side of the barrier wall than on the downgradient side, because of the low permeability (1×10^{-8} cm/sec) soil/bentonite backfill used to construct the barrier wall. Vector analysis of groundwater levels and Visual MODFLOW modeling of groundwater flow at piezometer pair PZ-2, which had a positive (outward) gradient across the wall on 27 days of the 90 day Interim Operating Period, indicates that groundwater preferentially flows through the 1×10^{-1} cm/sec aquifer material rather than through the 1×10^{-8} cm/sec soil/bentonite backfill.

For these reasons, it is considered appropriate to operate Sauget Area 2 Groundwater Migration Control System during a second 90 day Interim Operating Period using two performance measures:

- **Groundwater flow into the barrier wall**
- **Groundwater flow through the barrier wall**

Each of these performance measures is consistent with the FFS and ROD. The first performance measure, groundwater flow into the barrier wall, is controlled by gradient across Site R. Piezometer pairs PZ-1, 2, 3 and 4 can not measure gradient across Site R and need to be replaced with a groundwater level measurement system that can. Groundwater flow through the barrier wall is controlled by gradients across the barrier wall and piezometer pairs PZ-1, 2, 3 and 4 can be used to measure these gradients although groundwater level measurements in PZ-2 Outside and PZ-3 Outside will be influenced (lowered) by the barrier wall.

Surface water level, groundwater level and pumping rate data collected during Interim Operating Period II will be used to determine if controlling groundwater flow into and through the barrier will meet the intent of the Focused Feasibility Study and the Record of Decision. Both proposed performance measures are described in detail below.

6.2 Proposed Performance Measures

Groundwater Flow into Barrier Wall - The goal of the proposed second Interim Operating Period is to achieve an operating condition where groundwater flow into the Sauget Area 2 Groundwater Migration Control System is equal to the amount of groundwater extracted from it. Under this condition, flow in equals flow out ($Q_{In} = Q_{Out}$) and all of the groundwater entering the open end of the "U"-shaped barrier wall is controlled. Darcy's Law governs the amount of groundwater discharging into the "U"-shaped barrier wall:

$$Q = KIA$$

Where:

- Q = Groundwater Discharge
- K = Aquifer Hydraulic Conductivity
- I = Groundwater Gradient
- A = Groundwater Discharge Area

Aquifer hydraulic conductivity (K) and discharge area (A) are known quantities at Sauget Area 2 Site R, with hydraulic conductivity equal to 1×10^{-1} cm/sec (285 feet per day) and the groundwater discharge area is equal to the length of Site R parallel to the Mississippi River (2000 feet) multiplied by the saturated thickness of the Middle and Deep Hydrogeologic Units (100 feet).

Groundwater gradient is the variable that controls the amount of groundwater discharge to surface water downgradient of Sauget Area 2 Site R. If groundwater levels increase from upgradient to downgradient across Site R, groundwater gradients are positive and flow is from the Mississippi River to the American Bottoms aquifer. Under these conditions, groundwater extraction from the Sauget Area 2 Groundwater Migration Control System is not necessary because high surface water levels in the Mississippi River prevent the discharge of groundwater to surface water. When groundwater levels decrease from upgradient to downgradient across Site R, groundwater gradients are negative and operation of the Sauget Area 2 Groundwater Migration Control System is needed to control the discharge of groundwater

to surface water downgradient of Site R. During Interim Operating Period I, groundwater gradients across Site R were always negative when surface water levels in the Mississippi River was equal to or less than 391.60 ft NGVD and always positive when surface water levels were equal to or greater than 395.76 ft NGVD.

Data from Interim Operating Period I, summarized below, indicate that gradients across Site R are highly correlated to surface water levels in the Mississippi River (Table 12):

Comparison of Average Gradient Across Site R to Surface Water Level and Pumping Rate During Interim Operating Period

Week Number	Week Ending	Gradient vs. Surface Water Level Correlation Coefficient	Week Number	Week Ending	Gradient vs. Pumping Rate Correlation Coefficient
1	5-Dec- 04	-0.99	1	5- Dec-04	0.99
2	12-Dec-04	-0.92	2	12-Dec-04	0.63
3	19-Dec-04	-0.90	3	19-Dec-04	0.75
4	26-Dec-04	-0.97	4	26-Dec-04	0.98 [1]
5	2-Jan-05	-0.88	5	2-Jan-05	NA
6	9-Jan-05	-0.99	6	9-Jan-05	0.81
7	16-Jan-05	-0.95	7	16-Jan-05	0.69
8	23-Jan-05	-1.00	8	23-Jan-05	0.92
9	30-Jan-05	-0.98	9	30-Jan-05	0.97 [2]

Notes: 1) Data for days when pumping at full system capacity excluded because Q is not a variable at full flow.
2) Based on gradient from B-21B to PZ-1 Outside only. GWL data from PZ-4 Outside are suspect.
3) Upgradient groundwater level data is not available for February 2005 because of battery failure, faulty wiring and operator error.

Groundwater gradients across Site R also correlated very well (correlation coefficients of 0.99, 0.98, 0.92 and 0.97) or reasonably well (correlation coefficients of 0.75 and 0.81) with total system pumping rates during six of the 9 weeks of Interim Operating Period I where upgradient groundwater level data is available. Correlation coefficients were poor (0.63 and 0.69) during two weeks, however, this is to be expected because the Sauget Area 2 Groundwater Migration Control System was operated to maintain gradients across the barrier wall during Interim Operating Period I. The correlation between Site R gradient and pumping could not be determined for week 5 because the system was operating a full pumping capacity and flow rate was not a variable.

Groundwater gradients across Site R will be determined by installing two new fully-penetrating groundwater-level piezometers at the locations shown on Figure 4. One new fully-penetrating, groundwater-level piezometer will be installed at the north wing of the barrier wall approximately 500 feet east of existing piezometer PZ-1 Outside (Figure 4). This new piezometer will be installed just outside the barrier wall, most likely on the north side of River View Road, so groundwater level measurements will not be influenced by pumping from the Sauget Area 2 Groundwater Migration Control System. To determine groundwater gradients across Site R at the north wing of the barrier wall, groundwater levels in existing piezometer PZ-1 Outside will be subtracted from groundwater levels in the new piezometer (PZ-1 Upgradient) to determine the groundwater decrease or increase across Site R at the north wing of the

barrier wall. If the difference in groundwater levels between PZ-1 Upgradient and PZ-1 Outside is positive, surface water levels are high, flow is from the Mississippi River to the aquifer and pumping is not needed to control the discharge of groundwater.

When groundwater levels in PZ-1 Outside are lower than groundwater levels in PZ-1 Upgradient, the groundwater gradient across Site R at the north wing of the barrier wall will be determined by subtracting the groundwater level in PZ-1 Outside from the groundwater level in PZ-Upgradient and dividing by 500 ft, the distance between the two piezometers. The resultant number is the groundwater gradient across Site R at the north wing of the barrier wall.

Similarly, a new fully-penetrating, groundwater-level piezometer (PZ-4 Upgradient) will be installed at the south wing of the barrier wall approximately 450 feet east of PZ-4 Outside (Figure 4). This piezometer will be installed 25 to 50 feet south of the barrier wall, which is located on Eagle Marine property. Groundwater gradient across Site R will be determined in the same manner as for the north wing of the barrier wall except PZ-4 Upgradient and PZ-4 Outside will be used to determine the increase or decrease in groundwater levels and the gradient across Site R at the south wing of the barrier wall.

After calculating the gradient across Site R using the average of the groundwater gradients at the north and south wings of the barrier wall, the pump controller will determine the volume of groundwater discharging into the open end of the barrier wall using Darcy's Law. Sauget Area 2 Groundwater Migration Control System discharge rates will then be adjusted to match the calculated groundwater inflow rates so that $Q_{In} = Q_{Out}$.

When the groundwater extraction wells in the Sauget Area 2 Groundwater Migration Control System are operated so that flow into the open end of the barrier wall equals flow out at the extraction wells ($Q_{In} = Q_{Out}$), groundwater flow lines entering the entering the upgradient end of the "U"-shaped barrier wall should be straight, i.e. parallel to the north and south wings. Operating the extraction wells so that more groundwater is removed than enters the barrier wall ($Q_{In} < Q_{Out}$) results in groundwater flow lines that converge into the "U"-shaped barrier wall. When more groundwater enters the barrier wall than is removed by the extraction wells ($Q_{In} > Q_{Out}$), groundwater flow lines diverge around the "U"-shaped barrier wall. Consequently, converging and diverging flow lines indicate that the Sauget Area 2 Migration Control System is operating in a manner that does not achieve flow in equals flow out ($Q_{In} = Q_{Out}$).

To determine if groundwater flow lines are parallel to the north and south wings of the barrier wall ($Q_{In} = Q_{Out}$), six new fully-penetrating, groundwater-level piezometers will be installed at the upgradient, open end of the "U"-shaped barrier (Figure 4). Groundwater levels will be measured in each piezometer using electronic water-level recorders. At the end of each month during Interim Operating Period II, the groundwater level data will be used to calculate three daily flow vectors. Flow Vector 1 will be calculated

using groundwater-level data from PZ-5, 6 and 7. Flow Vector 2 will be calculated using groundwater-level data from PZ-6, 7, 8 and 9 and Flow Vector 3 will be calculated using groundwater level data from PZ-8, 9 and 10. Daily flow vectors will be included as a table in the monthly surface water level, groundwater level and pumping rate reports prepared to evaluate the effectiveness of using groundwater gradients across Site R to control the Sauget Area 2 Groundwater Migration Control System.

Groundwater Flow through Barrier Wall - A total of twelve monitoring wells, in four three-well clusters, were installed downgradient of the physical barrier to determine mass loading to the Mississippi River resulting from any contaminants migrating through, past or beneath the barrier wall (Figure 4). Each well cluster was screened in the Shallow, Middle and Deep Hydrogeologic Units. Groundwater quality samples will be collected downgradient of the physical barrier in Monitoring Well Clusters 1, 2, 3 and 4 analyzed for VOCs, SVOCs, Herbicides, Pesticides and Metals. TOC and TDS will also be determined for each sample. Groundwater samples will be collected quarterly until the final groundwater remedy and associated groundwater monitoring program for the Sauget Area 2 Site is in place.

Organic and inorganic mass loading to the Mississippi River downgradient of the barrier wall will be determined once a quarter or four times a year. The gradient across the barrier wall on the days samples are collected will be determined using groundwater levels from piezometer pairs PZ-2 and PZ-3 and Extraction Wells EW-1, 2 and 3. Seepage through the barrier wall will then be determined using vector analysis assuming wall permeability of 1.4×10^{-8} cm/sec and aquifer permeability of 1×10^{-1} cm/sec.

Mass loading for each hydrogeologic unit will be calculated using average TOC and TDS concentration in the unit. Total mass loading to the Mississippi River will be determined by summing the mass loads for the Shallow Hydrogeologic Unit, Middle Hydrogeologic Unit and Deep Hydrogeologic Unit. Total mass loading will be plotted over time to track changes in the amount of mass discharging to the Mississippi River.

Sediment and surface water sampling will be conducted twice a year, once during the winter low flow period (March 2005) and once during the summer low flow period (September 2005) when groundwater discharge to the Mississippi River is high and groundwater levels are low, to determine the effect of mass loading on the river. Samples will be collected at five sediment sampling stations where sediment and/or surface water toxicity was observed in October/November 2000 (Figure 4).

Figures

Tables

Attachments

Tables

TABLE 1
DECEMBER 2004 GROUNDWATER LEVEL, SURFACE WATER LEVEL, AND PUMPING RATE DATA

Sauget Area 2 Groundwater Migration Control System
Interim Operating Period 1 - December 2004 and January and February 2005
Sauget and Cahokia, Illinois

DATE	TOTAL PUMPING RATE (gpm)	SWL	GROUNDWATER LEVEL (OUTSIDE) COMPARED TO GROUNDWATER LEVEL (INSIDE)											
			PZ-1 O	PZ-1 I	Delta	PZ-2 O	PZ-2 I	Delta	PZ-3 O	PZ-3 I	Delta	PZ-4 O	PZ-4 I	Delta
1-Dec-04	196	395.31	392.59	389.46	-3.13	393.98	390.50	-3.48	393.24	389.63	-3.61	392.35	389.73	-2.62
2-Dec-04	239	394.82	392.47	389.10	-3.37	393.55	390.53	-3.03	392.88	389.74	-3.14	392.24	389.88	-2.35
3-Dec-04	319	393.88	392.02	388.54	-3.48	392.63	390.29	-2.34	392.04	389.46	-2.59	391.78	389.72	-2.06
4-Dec-04	450	392.94	391.58	388.30	-3.28	391.79	389.99	-1.80	391.30	389.19	-2.10	391.40	389.55	-1.85
5-Dec-04	599	391.53	390.89	388.10	-2.80	390.49	389.73	-0.77	390.14	388.86	-1.27	390.68	389.38	-1.30
6-Dec-04	1,097	391.11	390.57	387.24	-3.32	390.03	388.53	-1.50	389.58	387.43	-2.14	390.29	388.30	-2.00
7-Dec-04	668	394.30	392.08	387.77	-4.31	392.81	389.21	-3.60	392.09	388.46	-3.63	391.74	388.93	-2.81
8-Dec-04	156	397.99	394.32	389.28	-5.05	396.30	390.97	-5.33	395.37	390.52	-4.85	393.95	390.48	-3.47
9-Dec-04	29	397.82	394.65	390.15	-4.51	396.33	391.85	-4.48	395.50	391.48	-4.01	394.32	391.44	-2.88
10-Dec-04	20	396.99	394.33	390.38	-3.95	395.61	392.06	-3.55	394.85	391.60	-3.25	393.96	391.61	-2.35
11-Dec-04	14	395.35	393.50	390.46	-3.05	394.11	392.15	-1.96	393.56	391.56	-2.00	393.29	391.68	-1.61
12-Dec-04	365	393.80	392.66	389.94	-2.73	392.65	391.62	-1.03	392.23	390.67	-1.56	392.48	391.20	-1.28
13-Dec-04	592	393.04	392.08	388.93	-3.15	391.82	390.67	-1.15	391.44	389.79	-1.65	391.87	390.20	-1.66
14-Dec-04	722	392.34	391.63	388.44	-3.20	391.23	390.22	-1.02	390.84	389.59	-1.25	391.48	390.17	-1.31
15-Dec-04	861	391.81	391.38	388.00	-3.38	390.76	389.92	-0.84	390.46	389.53	-0.93	391.23	390.19	-1.04
16-Dec-04	1,218	391.41	391.09	386.63	-4.46	390.38	388.70	-1.68	390.02	388.50	-1.52	390.94	389.34	-1.60
17-Dec-04	856	390.88	390.82	387.46	-3.36	389.94	389.44	-0.50	389.71	389.06	-0.65	390.69	389.75	-0.94
18-Dec-04	1,445	389.88	390.18	385.91	-4.27	388.96	388.00	-0.96	388.75	387.88	-0.88	390.07	388.93	-1.14
19-Dec-04	1,391	389.92	390.04	385.56	-4.48	388.98	387.69	-1.29	388.68	387.55	-1.13	389.91	388.53	-1.39
20-Dec-04	1,802	388.88	389.53	384.96	-4.57	388.04	386.95	-1.09	387.83	386.10	-1.73	389.38	387.68	-1.70
21-Dec-04	1,738	388.37	389.06	384.58	-4.48	387.50	386.54	-0.97	387.30	386.06	-1.24	388.88	387.20	-1.68
22-Dec-04	1,870	387.32	388.43	383.85	-4.57	386.61	385.98	-0.63	386.43	385.72	-0.71	388.32	386.95	-1.37
23-Dec-04	2,164	385.08	387.14	383.06	-4.07	384.57	385.18	0.62	384.44	383.99	-0.45	387.05	385.30	-1.76
24-Dec-04	2,174	383.40	386.10	382.69	-3.41	383.03	384.83	1.80	382.95	383.49	0.54	386.05	384.88	-1.16
25-Dec-04	2,171	383.65	386.03	382.48	-3.55	383.04	384.62	1.58	382.99	383.30	0.31	385.92	384.70	-1.22
26-Dec-04	2,169	384.12	386.15	382.10	-4.05	383.53	384.25	0.72	383.35	382.99	-0.37	385.96	384.34	-1.62
27-Dec-04	2,170	383.99	386.00	381.90	-4.09	383.34	384.06	0.72	383.20	382.80	-0.40	385.77	384.18	-1.59
28-Dec-04	2,170	384.06	385.99	381.89	-4.10	383.44	384.04	0.60	383.30	382.80	-0.50	385.82	384.16	-1.66
29-Dec-04	2,163	383.70	385.70	381.70	-4.00	383.00	383.80	0.80	382.90	382.60	-0.30	385.50	383.90	-1.60
30-Dec-04	2,162	383.53	385.58	381.58	-4.00	382.94	383.71	0.77	382.86	382.49	-0.37	385.44	383.84	-1.60
31-Dec-04	2,161	382.70	384.99	381.28	-3.71	382.15	383.41	1.25	382.03	382.14	0.11	384.84	383.51	-1.33
Maximum	**2,174**	**397.99**			**-5.05**			**-5.33**			**-4.85**			**-3.47**
Average	**1,166**	**390.13**			**-3.80**			**-1.10**			**-1.53**			**-1.74**
Minimum	**14**	**382.70**			**-2.73**			**-0.50**			**0.11**			**-0.94**

Notes:
gpm = Gallons per minute
SWL = Surface water level
I = Inside
O = Outside

TABLE 2
JANUARY 2005 GROUNDWATER LEVEL, SURFACE WATER LEVEL, AND PUMPING RATE DATA

Sauget Area 2 Groundwater Migration Control System
Interim Operating Period 1 - December 2004 and January and February 2005
Sauget and Cahokia, Illinois

DATE	TOTAL PUMPING RATE (gpm)	SWL	GROUNDWATER LEVEL (OUTSIDE) COMPARED TO GROUNDWATER LEVEL (INSIDE)											
			PZ-1 O	PZ-1 I	Delta	PZ-2 O	PZ-2 I	Delta	PZ-3 O	PZ-3 I	Delta	PZ-4 O	PZ-4 I	Delta
1-Jan-05	2,162	383.08	385.13	381.11	-4.02	382.41	383.27	0.85	382.35	382.04	-0.30	384.95	383.40	-1.55
2-Jan-05	2,160	382.25	384.59	380.98	-3.61	381.69	383.13	1.44	381.63	381.85	0.22	384.42	383.20	-1.22
3-Jan-05	791	385.14	386.03	383.93	-2.10	384.29	385.88	1.59	384.05	384.56	0.51	385.79	385.23	-0.55
4-Jan-05	994	391.60	389.44	385.17	-4.27	390.03	386.73	-3.30	389.39	386.04	-3.35	388.90	386.73	-2.18
5-Jan-05	5	401.15	394.77	387.61	-7.16	398.91	389.30	-9.61	397.47	389.21	-8.26	393.78	388.89	-4.89
6-Jan-05	191	408.18	399.18	388.71	-10.47	405.58	390.10	-15.48	403.60	390.88	-12.72	398.25	390.38	-7.88
7-Jan-05	120	408.37	400.00	389.61	-10.39	405.90	391.08	-14.82	404.04	391.83	-12.21	399.44	391.39	-8.05
8-Jan-05	180	404.28	398.36	390.34	-8.03	402.26	391.93	-10.33	400.88	392.27	-8.61	397.93	391.98	-5.94
9-Jan-05	119	401.78	397.30	390.95	-6.35	399.98	392.58	-7.40	398.88	392.54	-6.34	396.90	392.45	-4.45
10-Jan-05	257	399.53	396.29	391.09	-5.20	398.01	392.43	-5.58	397.15	392.33	-4.82	395.95	392.47	-3.48
11-Jan-05	153	397.77	395.42	391.36	-4.06	396.38	392.85	-3.54	395.70	392.40	-3.30	395.10	392.62	-2.48
12-Jan-05	521	396.81	394.93	390.79	-4.14	395.49	NA	NA	394.87	391.57	-3.30	394.66	392.18	-2.48
13-Jan-05	343	400.00	396.45	390.88	-5.56	398.18	392.59	-5.59	397.24	392.13	-5.11	396.06	392.25	-3.81
14-Jan-05	20	405.15	399.57	392.49	-7.08	402.95	394.11	-8.84	401.62	394.18	-7.44	399.04	393.94	-5.10
15-Jan-05	3	405.04	399.96	393.23	-6.73	403.01	394.86	-8.15	401.76	394.89	-6.87	399.42	394.66	-4.76
16-Jan-05	3	401.78	398.33	393.48	-4.85	400.06	395.15	-4.91	399.17	394.88	-4.30	397.96	394.81	-3.15
17-Jan-05	9	400.17	397.89	NA	NA	NA	395.41	NA	397.96	394.95	-3.01	397.30	394.98	-2.32
18-Jan-05	180	NA	395.32	393.86	-1.45	394.56	396.64	2.09	394.83	396.48	1.65	397.97	396.28	-1.70
19-Jan-05	571	NA	395.31	393.28	-2.03	395.15	394.14	-1.00	394.04	393.70	-0.34	396.40	395.34	-1.06
20-Jan-05	802	395.76	395.13	393.20	-1.93	NA	393.85	NA	394.40	NA	NA	394.90	393.64	-1.27
21-Jan-05	965	395.49	394.95	392.91	-2.04	394.02	393.11	-0.91	394.13	NA	NA	NA	NA	NA
22-Jan-05	1,130	395.31	394.70	392.71	-1.99	393.83	392.89	-0.94	393.76	389.82	-3.94	NA	NA	NA
23-Jan-05	885	392.86	394.18	392.48	-1.70	393.04	392.65	-0.40	393.13	390.41	-2.72	NA	NA	NA
24-Jan-05	1,054	393.76	393.85	392.40	-1.45	392.45	392.60	0.15	392.66	390.79	-1.88	392.93	NA	NA
25-Jan-05	1,071	393.77	393.85	392.34	-1.51	392.50	392.71	0.22	392.62	390.30	-2.33	392.98	391.96	-1.02
26-Jan-05	1,122	393.26	393.41	391.93	-1.48	392.00	392.30	0.29	392.15	389.55	-2.60	392.72	391.68	-1.04
27-Jan-05	1,175	392.58	392.93	391.60	-1.32	391.34	392.02	0.68	391.53	389.79	-1.75	392.47	391.43	-1.04
28-Jan-05	1,264	391.90	392.50	391.09	-1.41	390.70	391.65	0.95	390.90	389.70	-1.20	392.04	391.07	-0.97
29-Jan-05	1,253	391.81	392.40	390.98	-1.42	390.61	391.57	0.96	390.78	389.58	-1.20	391.90	390.93	-0.97
30-Jan-05	1,246	391.65	392.26	390.85	-1.41	390.48	391.45	0.97	390.66	389.45	-1.21	391.76	390.80	-0.95
31-Jan-05	1,270	391.36	392.02	390.60	-1.42	390.20	391.21	1.01	390.35	389.24	-1.11	391.51	390.57	-0.95
Maximum	**2,162**	**408.37**			**-10.47**			**-15.48**			**-12.72**			**-8.05**
Average	**710**	**396.26**			**-3.89**			**-3.20**			**-3.72**			**-2.79**
Minimum	**3**	**382.25**			**-1.32**			**0.15**			**0.22**			**-0.55**

Notes:
gpm = Gallons per minute
SWL = Surface water level
I = Inside
O = Outside

TABLE 3
FEBRUARY 2005 GROUNDWATER LEVEL, SURFACE WATER LEVEL, AND PUMPING RATE DATA

Sauget Area 2 Groundwater Migration Control System
Interim Operating Period 1 - December 2004 and January and February 2005
Sauget and Cahokia, Illinois

DATE	TOTAL PUMPING RATE (gpm)	SWL	GROUNDWATER LEVEL (OUTSIDE) COMPARED TO GROUNDWATER LEVEL (INSIDE)											
			PZ-1 O	PZ-1 I	Delta	PZ-2 O	PZ-2 I	Delta	PZ-3 1	PZ-3 O	Delta	PZ-4 O	PZ-4 I	Delta
1-Feb-05	1,481	390.95	391.72	389.36	-2.36	389.82	390.36	0.55	390.01	388.93	-1.08	391.26	390.32	-0.94
2-Feb-05	594	390.19	391.34	390.12	-1.22	389.25	391.67	2.42	389.55	390.81	1.26	390.96	391.65	0.69
3-Feb-05	0	389.55	391.15	392.28	1.13	388.74	393.67	4.93	389.18	NA	NA	390.82	393.24	2.42
4-Feb-05	918	389.27	390.84	390.33	-0.52	388.46	391.90	3.44	388.82	390.94	2.12	390.60	391.91	1.31
5-Feb-05	1,956	389.00	390.41	386.45	-3.97	388.12	388.59	0.47	388.44	388.05	-0.38	390.21	389.62	-0.59
6-Feb-05	1,893	389.08	390.34	386.16	-4.18	388.23	388.33	0.10	388.50	388.05	-0.45	390.17	389.66	-0.51
7-Feb-05	1,682	389.63	390.58	386.48	-4.10	388.71	388.61	-0.10	388.93	388.32	-0.61	390.40	389.82	-0.58
8-Feb-05	1,174	391.27	391.45	387.93	-3.52	390.18	389.81	-0.37	390.35	389.39	-0.95	391.25	390.58	-0.67
9-Feb-05	1,116	391.65	391.72	388.34	-3.38	390.55	390.12	-0.42	390.71	389.69	-1.02	391.51	390.85	-0.66
10-Feb-05	876	392.49	392.13	389.00	-3.13	391.27	390.70	-0.57	391.38	390.20	-1.18	391.93	391.18	-0.75
11-Feb-05	642	393.61	392.87	390.03	-2.84	392.30	391.65	-0.65	392.38	391.11	-1.27	392.66	391.90	-0.77
12-Feb-05	777	393.60	392.97	390.05	-2.91	392.27	391.67	-0.60	392.38	391.14	-1.24	392.78	392.02	-0.76
13-Feb-05	772	393.75	393.04	390.05	-2.99	392.33	391.72	-0.61	392.42	391.21	-1.20	392.86	392.05	-0.81
14-Feb-05	45	397.57	395.17	392.30	-2.88	395.81	393.67	-2.14	395.71	393.15	-2.56	394.89	393.55	-1.34
15-Feb-05	13	401.59	397.70	393.20	-4.49	399.62	394.53	-5.09	399.23	394.33	-4.89	397.35	394.68	-2.67
16-Feb-05	13	403.72	399.13	393.75	-5.38	401.65	395.03	-6.62	401.12	394.96	-6.16	398.73	395.29	-3.44
17-Feb-05	0	403.60	399.31	394.25	-5.06	401.58	395.53	-6.04	401.10	395.40	-5.70	398.89	395.76	-3.13
18-Feb-05	13	402.58	398.88	394.55	-4.33	400.66	395.83	-4.83	400.29	395.63	-4.66	398.54	396.10	-2.44
19-Feb-05	13	401.83	398.66	394.85	-3.82	400.00	396.11	-3.89	399.74	395.88	-3.87	398.30	396.45	-1.85
20-Feb-05	13	400.72	398.20	395.17	-3.02	399.00	396.47	-2.54	398.88	396.11	-2.77	397.90	396.61	-1.30
21-Feb-05	55	399.27	397.39	395.02	-2.37	397.72	396.33	-1.38	397.68	395.80	-1.88	397.17	396.28	-0.90
22-Feb-05	400	397.80	396.49	394.11	-2.38	396.30	395.46	-0.84	394.60	394.75	0.15	396.27	395.39	-0.88
23-Feb-05	544	397.18	396.12	393.57	-2.55	395.72	394.94	-0.78	395.72	394.25	-1.47	395.89	395.03	-0.86
24-Feb-05	821	396.13	395.44	392.61	-2.83	394.74	394.15	-0.58	394.61	393.60	-1.01	395.25	394.46	-0.78
25-Feb-05	1,116	394.76	394.53	391.29	-3.24	393.43	393.03	-0.40	393.30	392.56	-0.74	394.36	393.65	-0.71
26-Feb-05	1,327	393.65	393.71	390.15	-3.56	392.33	392.03	-0.30	392.39	391.65	-0.73	393.55	392.92	-0.64
27-Feb-05	1,354	393.34	393.52	389.88	-3.64	392.08	391.78	-0.30	392.15	391.44	-0.71	393.33	392.69	-0.64
28-Feb-05	1,459	392.77	393.09	389.36	-3.73	391.53	391.32	-0.21	391.63	390.95	-0.68	392.90	392.33	-0.58
Maximum	**1,956**	**403.72**			**-5.38**			**-6.62**			**-6.16**			**-3.44**
Average	**752**	**395.02**			**-3.12**			**-0.98**			**-1.62**			**-0.88**
Minimum	**0**	**389.00**			**-0.52**			**0.10**			**0.15**			**-0.51**

Notes:
gpm = Gallons per minute
SWL = Surface water level
I = Inside
O = Outside

TABLE 4
DAYS WITH NEGATIVE (INWARD) GRADIENTS ACROSS BARRIER WALL

Sauget Area 2 Groundwater Migration Control System
Interim Operating Period 1 - December 2004 and January and February 2005
Sauget and Cahokia, Illinois

January	Day	TOTAL PUMPING RATE (gpm)	PZ-1 (feet)	PZ-2 (feet)	PZ-3 (feet)	PZ-4 (feet)	SWL (feet NGVD)
1-Dec-04	1	196	-3.13	-3.48	-3.61	-2.62	395.31
2-Dec-04	2	239	-3.37	-3.03	-3.14	-2.35	394.82
3-Dec-04	3	319	-3.48	-2.34	-2.59	-2.06	393.88
4-Dec-04	4	450	-3.28	-1.80	-2.10	-1.85	392.94
5-Dec-04	5	599	-2.80	-0.77	-1.28	-1.30	391.53
6-Dec-04	6	1,097	-3.33	-1.50	-2.14	-2.00	391.11
7-Dec-04	7	668	-4.31	-3.60	-3.63	-2.81	394.30
8-Dec-04	8	156	-5.05	-5.33	-4.85	-3.47	397.99
9-Dec-04	9	29	-4.51	-4.48	-4.01	-2.88	397.82
10-Dec-04	10	20	-3.95	-3.55	-3.25	-2.35	396.99
11-Dec-04	11	14	-3.05	-1.96	-2.00	-1.61	395.35
12-Dec-04	12	365	-2.73	-1.03	-1.56	-1.28	393.80
13-Dec-04	13	592	-3.15	-1.15	-1.65	-1.66	393.04
14-Dec-04	14	722	-3.20	-1.02	-1.25	-1.31	392.34
15-Dec-04	15	861	-3.38	-0.84	-0.93	-1.04	391.81
16-Dec-04	16	1,218	-4.46	-1.68	-1.52	-1.60	391.41
17-Dec-04	17	856	-3.36	-0.50	-0.65	-0.94	390.88
18-Dec-04	18	1,445	-4.27	-0.96	-0.87	-1.14	389.88
19-Dec-04	19	1,391	-4.48	-1.29	-1.13	-1.39	389.92
20-Dec-04	20	1,802	-4.57	-1.09	-1.73	-1.70	388.88
21-Dec-04	21	1,738	-4.48	-0.97	-1.24	-1.68	388.37
22-Dec-04	22	1,870	-4.58	-0.63	-0.71	-1.37	387.32
Maximum		**1,870**	**-5.05**	**-5.33**	**-4.85**	**-3.47**	**397.99**
Average		**757**	**-3.77**	**-1.95**	**-2.08**	**-1.84**	**392.71**
Minimum		**14**	**-2.73**	**-0.50**	**-0.65**	**-0.94**	**387.32**

TABLE 4
DAYS WITH NEGATIVE (INWARD) GRADIENTS ACROSS BARRIER WALL

Sauget Area 2 Groundwater Migration Control System
Interim Operating Period 1 - December 2004 and January and February 2005
Sauget and Cahokia, Illinois

January	Day	TOTAL PUMPING RATE (gpm)	PZ-1 (feet)	PZ-2 (feet)	PZ-3 (feet)	PZ-4 (feet)	SWL (feet NGVD)
4-Jan-05	1	994	-4.27	-3.30	-3.35	-2.18	391.60
5-Jan-05	2	5	-7.16	-9.61	-8.26	-4.89	401.15
6-Jan-05	3	191	-10.47	-15.48	-12.72	-7.88	408.18
7-Jan-05	4	120	-10.39	-14.82	-12.21	-8.05	408.37
8-Jan-05	5	180	-8.03	-10.33	-8.61	-5.94	404.28
9-Jan-05	6	119	-6.35	-7.40	-6.34	-4.45	401.78
10-Jan-05	7	257	-5.20	-5.58	-4.82	-3.48	399.53
11-Jan-05	8	153	-4.06	-3.54	-3.30	-2.48	397.77
12-Jan-05	9	521	-4.14	NA	-3.30	-2.48	396.81
13-Jan-05	10	343	-5.56	-5.59	-5.11	-3.81	400.00
14-Jan-05	11	20	-7.08	-8.84	-7.44	-5.10	405.15
15-Jan-05	12	3	-6.73	-8.15	-6.87	-4.76	405.04
16-Jan-05	13	3	-4.85	-4.91	-4.30	-3.15	401.78
17-Jan-05	14	9	NA	NA	-3.01	-2.32	400.17
19-Jan-05	15	571	-1.97	-0.89	-0.54	-1.06	NA
20-Jan-05	16	802	-1.93	NA	-2.15	-1.27	395.76
21-Jan-05	17	965	-2.04	-0.91	-7.38	NA	395.49
22-Jan-05	18	1,130	-1.99	-0.94	-3.94	0.00	395.31
23-Jan-05	19	885	-1.70	-0.40	-2.72	0.00	392.86
Maximum		**1,130**	**-10.47**	**-15.48**	**-12.72**	**-8.05**	**408.37**
Average		**383**	**-5.22**	**-6.29**	**-5.60**	**-3.52**	**400.06**
Minimum		**3**	**-1.70**	**-0.40**	**-0.54**	**0.00**	**391.60**

TABLE 4
DAYS WITH NEGATIVE (INWARD) GRADIENTS ACROSS BARRIER WALL

Sauget Area 2 Groundwater Migration Control System
Interim Operating Period 1 - December 2004 and January and February 2005
Sauget and Cahokia, Illinois

January	Day	TOTAL PUMPING RATE (gpm)	PZ-1 (feet)	PZ-2 (feet)	PZ-3 (feet)	PZ-4 (feet)	SWL (feet NGVD)
7-Feb-05	1	1,682	-4.10	-0.10	-0.61	-0.58	389.63
8-Feb-05	2	1,174	-3.52	-0.37	-0.95	-0.67	391.27
9-Feb-05	3	1,116	-3.38	-0.43	-1.02	-0.66	391.65
10-Feb-05	4	876	-3.13	-0.57	-1.18	-0.75	392.49
11-Feb-05	5	642	-2.84	-0.65	-1.27	-0.77	393.61
12-Feb-05	6	777	-2.91	-0.60	-1.24	-0.76	393.60
13-Feb-05	7	772	-2.99	-0.61	-1.20	-0.81	393.75
14-Feb-05	8	45	-2.88	-2.14	-2.56	-1.34	397.57
15-Feb-05	9	13	-4.49	-5.09	-4.89	-2.67	401.59
16-Feb-05	10	13	-5.38	-6.62	-6.16	-3.44	403.72
17-Feb-05	11	0	-5.06	-6.04	-5.70	-3.13	403.60
18-Feb-05	12	13	-4.33	-4.83	-4.66	-2.44	402.58
19-Feb-05	13	13	-3.82	-3.89	-3.87	-1.85	401.83
20-Feb-05	14	13	-3.02	-2.54	-2.77	-1.30	400.72
21-Feb-05	15	55	-2.37	-1.38	-1.88	-0.90	399.27
23-Feb-05	16	544	-2.55	-0.78	-1.47	-0.86	397.18
24-Feb-05	17	821	-2.83	-0.58	-1.01	-0.78	396.13
25-Feb-05	18	1,116	-3.24	-0.40	-0.74	-0.71	394.76
26-Feb-05	19	1,327	-3.56	-0.30	-0.73	-0.64	393.65
27-Feb-05	20	1,354	-3.64	-0.30	-0.71	-0.64	393.34
28-Feb-05	21	1,459	-3.73	-0.21	-0.68	-0.58	392.77
Maximum		**1,682**	**-5.38**	**-6.62**	**-6.16**	**-3.44**	**403.72**
Average		**658**	**-3.51**	**-1.83**	**-2.16**	**-1.25**	**396.41**
Minimum		**0**	**-2.37**	**-0.10**	**-0.61**	**-0.58**	**389.63**

Notes:
gpm = Gallons per minute
SWL = Surface water level

TABLE 5
BARRIER WALL GRADIENTS ON DAYS WITH HIGH SWL/LOW Q AND LOW SWL/HIGH Q

Sauget Area 2 Groundwater Migration Control System
Interim Operating Period 1 - December 2004 and January and February 2005
Sauget and Cahokia, Illinois

Days with Positive (Outward) Gradient Across Barrier Wall and Low Surface Water Levels and High System Pumping Rates

Date	Day	SWL (feet NGVD)	Q (gpm)	PZ-1 (feet)	PZ-2 (feet)	PZ-3 (feet)	PZ-4 (feet)
23-Dec-04	1	385.08	2,164	-4.08	0.62	-0.45	-1.76
24-Dec-04	2	383.40	2,174	-3.41	1.80	0.54	-1.16
25-Dec-04	3	383.65	2,171	-3.55	1.58	0.31	-1.22
26-Dec-04	4	384.12	2,169	-4.05	0.72	-0.37	-1.62
27-Dec-04	5	383.99	2,170	-4.09	0.72	-0.40	-1.59
28-Dec-04	6	384.06	2,170	-4.10	0.60	-0.50	-1.66
29-Dec-04	7	383.70	2,163	-4.00	0.80	-0.40	-1.60
30-Dec-04	8	383.53	2,162	-4.00	0.77	-0.37	-1.60
31-Dec-04	9	382.70	2,161	-3.71	1.25	0.11	-1.33
1-Jan-05	10	383.08	2,162	-4.02	0.85	-0.30	-1.55
2-Jan-05	11	382.25	2,160	-3.61	1.44	0.22	-1.22
Maximum		**385.08**	**2,174**	**-4.10**	**1.80**	**0.54**	**-1.76**
Average		**383.60**	**2,166**	**-3.87**	**1.01**	**-0.15**	**-1.48**
Minimum		**382.25**	**2,160**	**-3.41**	**0.60**	**0.11**	**-1.16**

Days with Negative (Inward) Gradient Across Barrier Wall High Surface Water Levels and Low System Pumping Rates

Date	Day	SWL (feet NGVD)	Q (gpm)	PZ-1 (feet)	PZ-2 (feet)	PZ-3 (feet)	PZ-4 (feet)
9-Dec-04	1	397.82	29	-4.51	-4.48	-4.01	-2.88
10-Dec-04	2	396.99	20	-3.95	-3.55	-3.25	-2.35
11-Dec-04	3	395.35	14	-3.05	-1.96	-2.00	-1.61
5-Jan-05	4	401.15	5	-7.16	-9.61	-8.26	-4.89
14-Jan-05	5	405.15	20	-7.08	-8.84	-7.44	-5.10
15-Jan-05	6	405.04	3	-6.73	-8.15	-6.87	-4.76
16-Jan-05	7	401.78	3	-4.85	-4.91	-4.30	-3.15
14-Feb-05	8	397.57	45	-2.88	-2.14	-2.56	-1.34
15-Feb-05	9	401.59	13	-4.49	-5.09	-4.89	-2.67
16-Feb-05	10	403.72	13	-5.38	-6.62	-6.16	-3.44
17-Feb-05	11	403.60	0	-5.06	-6.04	-5.70	-3.13
18-Feb-05	12	402.58	13	-4.33	-4.83	-4.66	-2.44
19-Feb-05	13	401.83	13	-3.82	-3.89	-3.87	-1.85
20-Feb-05	14	400.72	13	-3.02	-2.54	-2.77	-1.30
21-Feb-05	15	399.27	55	-2.37	-1.38	-1.88	-0.90
Maximum		**405.15**	**55**	**-7.16**	**-9.61**	**-8.26**	**-5.10**
Average		**400.94**	**17**	**-4.58**	**-4.94**	**-4.57**	**-2.79**
Minimum		**395.35**	**0**	**-2.37**	**-1.38**	**-1.88**	**-0.90**

Notes:
gpm = Gallons per minute
SWL = Surface water level
Q = Total pumping rate

TABLE 6
DAYS WITH POSITIVE (OUTWARD) GRADIENTS ACROSS BARRIER WALL

Sauget Area 2 Groundwater Migration Control System
Interim Operating Period 1 - December 2004 and January and February 2005
Sauget and Cahokia, Illinois

December	Day	TOTAL PUMPING RATE (gpm)	PZ-1 (feet)	PZ-2 (feet)	PZ-3 (feet)	PZ-4 (feet)	SWL (feet NGVD)
23-Dec-04	1	2,164	-4.08	0.62	-0.45	-1.76	385.08
24-Dec-04	2	2,174	-3.41	1.80	0.54	-1.16	383.40
25-Dec-04	3	2,171	-3.55	1.58	0.31	-1.22	383.65
26-Dec-04	4	2,169	-4.05	0.72	-0.37	-1.62	384.12
27-Dec-04	5	2,170	-4.09	0.72	-0.40	-1.59	383.99
28-Dec-04	6	2,170	-4.10	0.60	-0.50	-1.66	384.06
29-Dec-04	7	2,163	-4.00	0.80	-0.40	-1.60	383.70
30-Dec-04	8	2,162	-4.00	0.77	-0.37	-1.60	383.53
31-Dec-04	9	2,161	-3.71	1.25	0.11	-1.33	382.70
Maximum		**2,174**	**-4.10**	**1.80**	**0.54**	**-1.76**	**385.08**
Average		**2,167**	**-3.89**	**0.98**	**-0.17**	**-1.50**	**383.81**
Minimum		**2,161**	**-3.41**	**0.60**	**0.11**	**-1.16**	**382.70**

December	Day	TOTAL PUMPING RATE (gpm)	PZ-1 (feet)	PZ-2 (feet)	PZ-3 (feet)	PZ-4 (feet)	SWL (feet NGVD)
1-Jan-05	1	2,162	-4.02	0.85	-0.30	-1.55	383.08
2-Jan-05	2	2,160	-3.61	1.44	0.22	-1.22	382.25
3-Jan-05	3	791	-2.10	1.59	0.51	-0.55	385.14
18-Jan-05	4	180	-1.15	2.09	1.53	-1.70	NA
24-Jan-05	5	1,054	-1.45	0.24	-1.88	-1.23	393.76
25-Jan-05	6	1,071	-1.51	0.22	-2.33	-1.02	393.77
26-Jan-05	7	1,122	-1.48	0.29	-2.60	-1.04	393.26
27-Jan-05	8	1,175	-1.32	0.68	-1.75	-1.04	392.58
28-Jan-05	9	1,264	-1.41	0.95	-1.20	-0.97	391.90
29-Jan-05	10	1,253	-1.42	0.96	-1.20	-0.97	391.81
30-Jan-05	11	1,246	-1.41	0.98	-1.21	-0.95	391.65
31-Jan-05	12	1,270	-1.42	1.01	-1.11	-0.95	391.36
Maximum		**2,162**	**-4.02**	**2.09**	**-2.60**	**-1.70**	**393.77**
Average		**1,229**	**-1.86**	**0.94**	**-0.94**	**-1.10**	**390.05**
Minimum		**180**	**-1.15**	**0.22**	**0.22**	**-0.55**	**382.25**

TABLE 6
DAYS WITH POSITIVE (OUTWARD) GRADIENTS ACROSS BARRIER WALL

Sauget Area 2 Groundwater Migration Control System
Interim Operating Period 1 - December 2004 and January and February 2005
Sauget and Cahokia, Illinois

December	Day	TOTAL PUMPING RATE (gpm)	PZ-1 (feet)	PZ-2 (feet)	PZ-3 (feet)	PZ-4 (feet)	SWL (feet NGVD)
2/1/05	1	1,481	-2.36	0.55	-1.08	-0.94	390.95
2/2/05	2	594	-1.23	2.42	1.26	0.69	390.19
2/3/05	3	0	1.13	4.93	3.57	2.42	389.55
2/4/05	4	918	-0.52	3.44	2.12	1.31	389.27
2/5/05	5	1,956	-3.97	0.47	-0.38	-0.59	389.00
2/6/05	6	1,893	-4.18	0.10	-0.45	-0.51	389.08
2/22/05	7	400	-2.38	-0.84	0.15	-0.88	397.80
Maximum		**1,956**	**-4.18**	**-0.84**	**-1.08**	**-0.94**	**397.80**
Average		**1,433**	**-3.22**	**0.07**	**-0.44**	**-0.73**	**390.83**
Minimum		**400**	**-2.36**	**0.10**	**0.15**	**-0.51**	**389.00**

Notes:
gpm = Gallons per minute
SWL = Surface water level
= Pumps out of service to install actuator valves

TABLE 7
AVERAGE DAILY AND WEEKLY GRADIENTS ACROSS BARRIER WALL IN PIEZOMETER PAIRS PZ-1, 2, 3, AND 4

Sauget Area 2 Groundwater Migration Control System
Interim Operating Period 1 - December 2004 and January and February 2005
Sauget and Cahokia, Illinois

December	PZ-1 (feet)	PZ-2 (feet)	PZ-3 (feet)	PZ-4 (feet)	Daily Average (feet)	Weekly Average (feet)
12/1/04	-3.13	-3.5	-3.6	-2.6	**-3.21**	
12/2/04	-3.37	-3.0	-3.1	-2.4	**-2.97**	
12/3/04	-3.48	-2.3	-2.6	-2.1	**-2.62**	
12/4/04	-3.28	-1.8	-2.1	-1.8	**-2.26**	
12/5/04	-2.80	-0.8	-1.3	-1.3	**-1.53**	
Average	**-3.21**	**-2.28**	**-2.54**	**-2.04**		**-2.52**
12/6/04	-3.33	-1.5	-2.1	-2.0	**-2.24**	
12/7/04	-4.31	-3.6	-3.6	-2.8	**-3.59**	
12/8/04	-5.05	-5.3	-4.8	-3.5	**-4.67**	
12/9/04	-4.51	-4.5	-4.0	-2.9	**-3.97**	
12/10/04	-3.95	-3.5	-3.2	-2.3	**-3.27**	
12/11/04	-3.05	-2.0	-2.0	-1.6	**-2.15**	
12/12/04	-2.73	-1.0	-1.6	-1.3	**-1.65**	
Average	**-3.84**	**-3.06**	**-3.06**	**-2.34**		**-3.08**
12/13/04	-3.15	-1.15	-1.65	-1.66	**-1.90**	
12/14/04	-3.20	-1.02	-1.25	-1.31	**-1.69**	
12/15/04	-3.38	-0.84	-0.93	-1.04	**-1.55**	
12/16/04	-4.46	-1.68	-1.52	-1.60	**-2.32**	
12/17/04	-3.36	-0.50	-0.65	-0.94	**-1.36**	
12/18/04	-4.27	-0.96	-0.87	-1.14	**-1.81**	
12/19/04	-4.48	-1.3	-1.1	-1.4	**-2.07**	
Average	**-3.76**	**-1.06**	**-1.15**	**-1.30**		**-1.82**
12/20/04	-4.57	-1.09	-1.73	-1.70	**-2.27**	
12/21/04	-4.48	-0.97	-1.24	-1.68	**-2.09**	
12/22/04	-4.58	-0.63	-0.71	-1.37	**-1.82**	
12/23/04	-4.08	0.62	-0.45	-1.76	**-1.42**	
12/24/04	-3.41	1.80	0.54	-1.16	**-0.56**	
12/25/04	-3.55	1.58	0.31	-1.22	**-0.72**	
12/26/04	-4.05	0.7	-0.4	-1.6	**-1.33**	
Average	**-4.10**	**0.29**	**-0.52**	**-1.50**		**-1.46**
12/27/04	-4.09	0.72	-0.40	-1.59	**-1.34**	
12/28/04	-4.10	0.60	-0.50	-1.66	**-1.42**	
12/29/04	-4.00	0.80	-0.40	-1.60	**-1.30**	
12/30/04	-4.00	0.77	-0.37	-1.60	**-1.30**	
12/31/04	-3.71	1.3	0.1	-1.3	**-0.92**	
Average	**-3.98**	**0.83**	**-0.31**	**-1.56**		**-1.26**

Daily Average	**-2.04**
Weekly Average	**-2.03**

TABLE 7
AVERAGE DAILY AND WEEKLY GRADIENTS ACROSS BARRIER WALL IN PIEZOMETER PAIRS PZ-1, 2, 3, AND 4

Sauget Area 2 Groundwater Migration Control System
Interim Operating Period 1 - December 2004 and January and February 2005
Sauget and Cahokia, Illinois

January	PZ-1 (feet)	PZ-2 (feet)	PZ-3 (feet)	PZ-4 (feet)	Daily Average (feet)	Weekly Average (feet)
1/1/05	-4.02	0.9	-0.3	-1.6	**-1.26**	
1/2/05	-3.61	1.4	0.2	-1.2	**-0.79**	
Average	**-3.81**	**1.15**	**-0.04**	**-1.39**		**-1.02**
1/3/05	-2.10	1.6	0.5	-0.6	**-0.14**	
1/4/05	-4.27	-3.3	-3.4	-2.2	**-3.27**	
1/5/05	-7.16	-9.6	-8.3	-4.9	**-7.48**	
1/6/05	-10.47	-15.5	-12.7	-7.9	**-11.64**	
1/7/05	-10.39	-14.8	-12.2	-8.1	**-11.37**	
1/8/05	-8.03	-10.3	-8.6	-5.9	**-8.23**	
1/9/05	-6.35	-7.4	-6.3	-4.4	**-6.14**	
Average	**-6.97**	**-8.48**	**-7.28**	**-4.85**		**-6.89**
1/10/05	-5.20	-5.6	-4.8	-3.5	**-4.77**	
1/11/05	-4.06	-3.5	-3.3	-2.5	**-3.35**	
1/12/05	-4.14	NA	-3.3	-2.5	**-3.31**	
1/13/05	-5.56	-5.6	-5.1	-3.8	**-5.02**	
1/14/05	-7.08	-8.8	-7.4	-5.1	**-7.11**	
1/15/05	-6.73	-8.2	-6.9	-4.8	**-6.63**	
1/16/05	-4.85	-4.9	-4.3	-3.1	**-4.30**	
Average	**-5.38**	**-6.10**	**-5.02**	**-3.61**		**-5.03**
1/17/05	NA	NA	-3.0	-2.3	**-2.66**	
1/18/05	-1.15	2.1	1.5	-1.7	**0.19**	
1/19/05	-1.97	-0.9	-0.5	-1.1	**-1.12**	
1/20/05	-1.93	NA	-2.1	-1.3	**-1.78**	
1/21/05	-2.04	-0.9	-7.4	NA	**-3.44**	
1/22/05	-1.99	-0.9	-3.9	0.0	**-1.72**	
1/23/05	-1.70	-0.4	-2.7	0.0	**-1.20**	
Average	**-1.80**	**-0.21**	**-2.60**	**-1.06**		**-1.42**
1/24/05	-1.45	0.2	-1.9	-1.2	**-1.08**	
1/25/05	-1.51	0.2	-2.3	-1.0	**-1.16**	
1/26/05	-1.48	0.3	-2.6	-1.0	**-1.21**	
1/27/05	-1.32	0.7	-1.7	-1.0	**-0.86**	
1/28/05	-1.41	0.9	-1.2	-1.0	**-0.66**	
1/29/05	-1.42	1.0	-1.2	-1.0	**-0.66**	
1/30/05	-1.41	1.0	-1.2	-1.0	**-0.65**	
Average	**-1.43**	**0.62**	**-1.74**	**-1.03**		**-0.90**
1/31/05	-1.42	1.0	-1.1	-0.9	**-0.61**	
Average	**-1.42**	**1.01**	**-1.11**	**-0.95**		**-0.61**

Daily Average	**-3.34**
Weekly Average	**-2.65**

TABLE 7
AVERAGE DAILY AND WEEKLY GRADIENTS ACROSS BARRIER WALL IN PIEZOMETER PAIRS PZ-1, 2, 3, AND 4

Sauget Area 2 Groundwater Migration Control System
Interim Operating Period 1 - December 2004 and January and February 2005
Sauget and Cahokia, Illinois

February	PZ-1 (feet)	PZ-2 (feet)	PZ-3 (feet)	PZ-4 (feet)	Daily Average (feet)	Weekly Average (feet)	
2/1/05	-2.36	0.55	-1.08	-0.94	**-0.96**		
2/2/05	-1.23	2.42	1.26	0.69	**0.79**		Note 1
2/3/05	1.13	4.93	3.57	2.42	**3.01**		Note 2
2/4/05	-0.52	3.44	2.12	1.31	**1.59**		Note 3
2/5/05	-3.97	0.47	-0.38	-0.59	**-1.12**		
2/6/05	-4.18	0.10	-0.45	-0.51	**-1.26**		
Average	**-1.85**	**1.98**	**0.84**	**0.40**		**0.34**	Note 4
2/7/05	-4.10	-0.10	-0.61	-0.58	**-1.34**		
2/8/05	-3.52	-0.37	-0.95	-0.67	**-1.38**		
2/9/05	-3.38	-0.43	-1.02	-0.66	**-1.37**		
2/10/05	-3.13	-0.57	-1.18	-0.75	**-1.41**		
2/11/05	-2.84	-0.65	-1.27	-0.77	**-1.38**		
2/12/05	-2.91	-0.60	-1.24	-0.76	**-1.38**		
2/13/05	-2.99	-0.61	-1.20	-0.81	**-1.40**		
Average	**-3.27**	**-0.47**	**-1.07**	**-0.71**		**-1.38**	
2/14/05	-2.88	-2.14	-2.56	-1.34	**-2.23**		
2/15/05	-4.49	-5.09	-4.89	-2.67	**-4.29**		
2/16/05	-5.38	-6.62	-6.16	-3.44	**-5.40**		
2/17/05	-5.06	-6.04	-5.70	-3.13	**-4.98**		
2/18/05	-4.33	-4.83	-4.66	-2.44	**-4.07**		
2/19/05	-3.82	-3.89	-3.87	-1.85	**-3.36**		
2/20/05	-3.02	-2.54	-2.77	-1.30	**-2.41**		
Average	**-4.14**	**-4.45**	**-4.37**	**-2.31**		**-3.82**	
2/21/05	-2.37	-1.38	-1.88	-0.90	**-1.63**		
2/22/05	-2.38	-0.84	0.15	-0.88	**-0.99**		
2/23/05	-2.55	-0.78	-1.47	-0.86	**-1.41**		
2/24/05	-2.83	-0.58	-1.01	-0.78	**-1.30**		
2/25/05	-3.24	-0.40	-0.74	-0.71	**-1.27**		
2/26/05	-3.56	-0.30	-0.73	-0.64	**-1.31**		
2/27/05	-3.64	-0.30	-0.71	-0.64	**-1.32**		
Average	**-2.94**	**-0.65**	**-0.91**	**-0.77**		**-1.32**	
2/28/05	-3.73	-0.21	-0.68	-0.58	**-1.30**		
Average	**-3.73**	**-0.21**	**-0.68**	**-0.58**		**-1.30**	

Daily Average	**-1.59**
Weekly Average	**-1.50**

NOTES:
1. February 2, 2005 - Pumps turned off.
2. February 3, 2005 - Actuator valves installed on extraction wells.
3. February 4, 2005 - Pumps turned on.
4. Positive (shaded) numbers indicate outward gradient across barrier wall.
5. Negative numbers indicate inward gradient across barrier wall.

TABLE 8
PREDICTED (DARCY) FLOW INTO BARRIER WALL VERSUS ACTUAL SYSTEM FLOW OUT

Sauget Area 2 Groundwater Migration Control System
Interim Operating Period 1 - December 2004 and January and February 2005
Sauget and Cahokia, Illinois

Date	SWL (ft. NGVD)	B-21B GWL (ft. NGVD)	PZ-1 Outside GWL (ft. NGVD)	Gradient Across Site R (feet/feet)	Predicted Flow Into Barrier Wall (gpm)	Actual Flow Out of Barrier Wall (gpm)	Amount of Under or Over Pumping (gpm)	Amount of Under or Over Pumping (gpd)	Daily Treatment Cost Increase ($)	Average Gradient Across Wall (feet)
12/1/04	395.31	391.06	392.6	-0.0029	0	196	196	282,726	1,414	-3.21
12/2/04	394.82	391.37	392.5	-0.0021	0	239	239	344,784	1,724	-2.97
12/3/04	393.88	391.39	392.0	-0.0012	0	319	319	458,976	2,295	-2.62
12/4/04	392.94	391.39	391.6	-0.00036	0	450	450	647,958	3,240	-2.26
12/5/04	391.53	391.36	390.9	0.00088	262	599	337	485,772	2,429	-1.53
12/6/04	391.11	391.05	390.6	0.00091	270	1,097	827	1,191,120	5,956	-2.24
12/7/04	394.30	391.03	392.1	-0.0020	0	668	668	962,394	4,812	-3.59
12/8/04	397.99	391.68	394.3	-0.0050	0	156	156	224,802	1,124	-4.67
12/9/04	397.82	392.39	394.7	-0.0043	0	29	29	42,258	211	-3.97
12/10/04	396.99	392.64	394.3	-0.0032	0	20	20	29,046	145	-3.27
12/11/04	395.35	392.81	393.5	-0.0013	0	14	14	19,548	98	-2.15
12/12/04	393.80	392.87	392.7	0.00039	116	365	249	357,992	1,790	-1.65
12/13/04	393.04	392.34	392.08	0.00050	148	592	444	639,438	3,197	-1.90
12/14/04	392.34	392.18	391.63	0.0010	305	722	417	600,573	3,003	-1.69
12/15/04	391.81	392.13	391.38	0.0014	417	861	444	639,447	3,197	-1.55
12/16/04	391.41	391.65	391.09	0.0011	314	1,218	904	1,302,052	6,510	-2.32
12/17/04	390.88	391.67	390.82	0.0016	474	856	381	549,346	2,747	-1.36
12/18/04	389.88	391.35	390.18	0.0022	654	1,445	791	1,138,465	5,692	-1.81
12/19/04	389.92	390.88	390.04	0.0016	468	1,391	923	1,328,545	6,643	-2.07
12/20/04	388.88	390.80	389.53	0.0024	710	1,802	1,093	1,573,210	7,866	-1.82
12/21/04	388.37	390.28	389.06	0.0023	682	1,738	1,056	1,520,470	7,602	-2.27
12/22/04	387.32	389.97	388.43	0.0029	863	1,870	1,007	1,449,544	7,248	-2.09
12/23/04	385.08	389.50	387.14	0.0045	1,320	2,164	845	1,216,260	6,081	-1.42
12/24/04	383.40	389.14	386.10	0.0057	1,698	2,174	475	684,672	3,423	-0.56
12/25/04	383.65	388.84	386.03	0.0053	1,570	2,171	600	864,454	4,322	-0.72
12/26/04	384.12	388.44	386.15	0.0043	1,279	2,169	889	1,280,823	6,404	-1.33
12/27/04	383.99	388.25	386.00	0.0043	1,259	2,170	911	1,311,215	6,556	-1.34
12/28/04	384.06	388.16	385.99	0.0041	1,214	2,170	956	1,376,846	6,884	-1.42
12/29/04	383.70	387.91	385.70	0.0042	1,235	2,163	929	1,337,457	6,687	-1.30
12/30/04	383.53	387.80	385.58	0.0042	1,243	2,162	919	1,323,764	6,619	-1.30
12/31/04	382.70	387.52	384.99	0.0048	1,412	2,161	749	1,078,577	5,393	-0.92
Maximum	**397.99**	**392.87**	**394.65**	**0.0057**	**1,698**	**2,174**	**1,093**	**1,573,210**	**7,866**	**-4.67**
Average	**390.13**	**390.64**	**389.99**	**0.0028**	**578**	**1,166**	**588**	**847,179**	**4,236**	**-2.04**
Minimum	**382.70**	**387.52**	**384.99**	**-0.0050**	**0**	**14**	**14**	**19,548**	**98**	**-0.56**
							Total	**26,262,535**	**161,252**	

TABLE 8
PREDICTED (DARCY) FLOW INTO BARRIER WALL VERSUS ACTUAL SYSTEM FLOW OUT

Sauget Area 2 Groundwater Migration Control System
Interim Operating Period 1 - December 2004 and January and February 2005
Sauget and Cahokia, Illinois

Date	SWL (ft. NGVD)	B-21B GWL (ft. NGVD)	PZ-1 Outside GWL (ft. NGVD)	Gradient Across Site R (feet/feet)	Predicted Flow Into Barrier Wall (gpm)	Actual Flow Out of Barrier Wall (gpm)	Amount of Under or Over Pumping (gpm)	Amount of Under or Over Pumping (gpd)	Daily Treatment Cost Increase ($)	Average Gradient Across Wall (feet)
1/1/05	383.08	387.35	385.1	0.0042	1,241	2,162	922	1,327,314	6,637	-1.26
1/2/05	382.25	387.17	384.6	0.0049	1,443	2,160	718	1,033,515	5,168	-0.79
1/3/05	385.14	387.48	386.0	0.0027	813	791	-22	-31,066	-155	-0.14
1/4/05	391.60	388.47	389.4	-0.0018	0	994	994	1,430,664	7,153	-3.27
1/5/05	401.15	389.37	394.8	-0.010	0	5	5	6,990	35	-7.48
1/6/05	408.18	390.61	399.2	-0.016	0	191	191	274,902	1,375	-11.64
1/7/05	408.37	391.75	400.0	-0.016	0	120	120	173,304	867	-11.37
1/8/05	404.28	392.60	398.4	-0.011	0	180	180	259,908	1,300	-8.23
1/9/05	401.78	393.32	397.3	-0.0075	0	119	119	170,730	854	-6.14
1/10/05	399.53	393.67	396.3	-0.0049	0	257	257	370,134	1,851	-4.77
1/11/05	397.77	393.93	395.4	-0.0028	0	153	153	220,884	1,104	-3.35
1/12/05	396.81	394.06	394.9	-0.0016	0	521	521	750,870	3,754	-3.31
1/13/05	400.00	393.92	396.45	-0.0048	0	343	343	493,494	2,467	-5.02
1/14/05	405.15	394.93	399.57	-0.0087	0	20	20	28,830	144	-7.11
1/15/05	405.04	395.79	399.96	-0.0079	0	3	3	4,116	21	-6.63
1/16/05	401.78	396.07	398.33	-0.0043	0	3	3	4,848	24	-4.30
1/17/05	400.17	396.26	397.89	-0.0031	0	9	9	12,510	63	-2.66
1/18/05	NA	396.41	395.32	0.0021	611	180	-430	-619,752	-3,099	0.19
1/19/05	NA	396.13	395.31	0.0015	459	571	112	161,930	810	-1.12
1/20/05	395.76	395.91	395.13	0.0015	436	802	365	526,213	2,631	-1.78
1/21/05	395.49	395.64	394.95	0.0013	387	965	579	833,178	4,166	-3.44
1/22/05	395.31	395.43	394.70	0.0014	410	1,130	720	1,036,616	5,183	-1.72
1/23/05	392.86	395.28	394.18	0.0021	615	885	271	389,529	1,948	-1.20
1/24/05	393.76	395.30	393.85	0.0027	812	1,054	241	347,257	1,736	-1.08
1/25/05	393.77	395.23	393.85	0.0026	770	1,071	301	433,407	2,167	-1.16
1/26/05	393.26	394.86	393.41	0.0027	809	1,122	314	451,782	2,259	-1.21
1/27/05	392.58	394.58	392.93	0.0031	925	1,175	250	360,470	1,802	-0.86
1/28/05	391.90	394.46	392.50	0.0037	1,095	1,264	169	242,762	1,214	-0.66
1/29/05	391.81	394.37	392.40	0.0037	1,098	1,253	155	223,316	1,117	-0.66
1/30/05	391.65	394.24	392.26	0.0037	1,107	1,246	139	199,796	999	-0.65
1/31/05	391.36	394.06	392.02	0.0039	1,142	1,270	128	184,815	924	-0.61
Maximum	**408.37**	**396.41**	**400.00**	**0.0049**	**1,443**	**2,162**	**994**	**1,430,664**	**7,153**	**-11.64**
Average	**396.26**	**393.50**	**394.40**	**0.0028**	**457**	**710**	**253**	**364,621**	**1,823**	**-3.34**
Minimum	**382.25**	**387.17**	**384.59**	**-0.016**	**0**	**3**	**-430**	**-619,752**	**-3,099**	**-0.14**
							Total	**11,303,266**	**109,529**	

TABLE 8
PREDICTED (DARCY) FLOW INTO BARRIER WALL VERSUS ACTUAL SYSTEM FLOW OUT

Sauget Area 2 Groundwater Migration Control System
Interim Operating Period 1 - December 2004 and January and February 2005
Sauget and Cahokia, Illinois

Date	SWL (ft. NGVD)	B-21B GWL (ft. NGVD)	PZ-1 Outside GWL (ft. NGVD)	Gradient Across Site R (feet/feet)	Predicted Flow Into Barrier Wall (gpm)	Actual Flow Out of Barrier Wall (gpm)	Amount of Under or Over Pumping (gpm)	Amount of Under or Over Pumping (gpd)	Daily Treatment Cost Increase ($)	Average Gradient Across Wall (feet)
2/1/05	390.95	NA	391.7	0.0026	765	1,481	716	1,031,145	5,156	-0.96
2/2/05	390.19	NA	391.3	0.0038	1,135	594	-541	-778,928	-3,895	0.79
2/3/05	389.55	NA	391.2	0.0053	1,575	0	-1,575	-2,267,996	-11,340	3.01
2/4/05	389.27	NA	390.8	0.0052	1,550	918	-633	-910,924	-4,555	1.59
2/5/05	389.00	NA	390.4	0.0047	1,398	1,956	558	803,330	4,017	-1.12
2/6/05	389.08	NA	390.3	0.0042	1,250	1,893	643	925,219	4,626	-1.26
2/7/05	389.63	NA	390.6	0.0032	933	1,682	748	1,077,149	5,386	-1.34
2/8/05	391.27	NA	391.5	0.00060	177	1,174	997	1,436,175	7,181	-1.38
2/9/05	391.65	NA	391.7	0.00024	70	1,116	1,046	1,506,870	7,534	-1.37
2/10/05	392.49	NA	392.1	-0.0012	0	876	876	1,261,122	6,306	-1.41
2/11/05	393.61	NA	392.9	-0.0025	0	642	642	925,026	4,625	-1.38
2/12/05	393.60	NA	393.0	-0.0021	0	777	777	1,118,700	5,594	-1.38
2/13/05	393.75	NA	393.04	-0.0024	0	772	772	1,112,352	5,562	-1.40
2/14/05	397.57	NA	395.17	-0.0080	0	45	45	64,110	321	-2.23
2/15/05	401.59	NA	397.70	-0.013	0	13	13	18,438	92	-4.29
2/16/05	403.72	NA	399.13	-0.015	0	13	13	18,552	93	-5.40
2/17/05	403.60	NA	399.31	-0.014	0	-11	-11	-15,252	-76	-4.98
2/18/05	402.58	NA	398.88	-0.012	0	13	13	18,804	94	-4.07
2/19/05	401.83	NA	398.66	-0.011	0	13	13	18,378	92	-3.36
2/20/05	400.72	NA	398.20	-0.0084	0	13	13	18,330	92	-2.41
2/21/05	399.27	NA	397.39	-0.0063	0	55	55	79,344	397	-1.63
2/22/05	397.80	NA	396.49	-0.0043	0	400	400	576,600	2,883	-0.99
2/23/05	397.18	NA	396.12	-0.0035	0	544	544	783,552	3,918	-1.41
2/24/05	396.13	NA	395.44	-0.0023	0	821	821	1,182,048	5,910	-1.30
2/25/05	394.76	NA	394.53	-0.00078	0	1,116	1,116	1,607,532	8,038	-1.27
2/26/05	393.65	NA	393.71	0.00018	53	1,327	1,273	1,833,430	9,167	-1.31
2/27/05	393.34	NA	393.52	0.00058	173	1,354	1,181	1,700,648	8,503	-1.32
2/28/05	392.77	NA	393.09	0.0011	321	1,459	1,139	1,639,653	8,198	-1.30
Maximum	**403.72**	**NA**	**399.31**	**0.0053**	**1,575**	**1,956**	**1,273**	**1,833,430**	**9,167**	**-5.40**
Average	**395.02**	**NA**	**394.21**	**0.0026**	**336**	**752**	**416**	**599,407**	**2,997**	**-1.60**
Minimum	**389.00**	**NA**	**390.34**	**-0.015**	**0**	**-11**	**-1,575**	**-2,267,996**	**-11,340**	**0.79**
							Total	**16,783,407**	**235,471**	

NOTES:
1. Q = KIA, with (K = 285 ft per day) x(A = 200,000 square feet) = 57,000,000 cubic feet per day.
2. 57,000,000 cubic feet per day = 426,360,000 gallons per day or 296,083 gallons per minute.
3. GWL data not available for B-21B in February; PZ-1 Outside and SWL used to determine gradient.
4. December 2004 treatment charges were $6.14 per thousand gallons.
5. January 2005 treatment charges were $9.69 per thousand gallons.
6. February 2005 treatment charges were $14.03 per thousand gallons.

TABLE 9
COMPARISON OF PZ-2 OUTSIDE AND PZ-3 OUTSIDE GROUNDWATER LEVELS TO SURFACE WATER LEVELS

Sauget Area 2 Groundwater Migration Control System
Interim Operating Period 1 - December 2004 and January and February 2005
Sauget and Cahokia, Illinois

December	SWL (feet NGVD)	PZ- 2 O (feet)	Delta (feet)	PZ-3 O (feet)	Delta (feet)
12/1/2004	395.31	393.98	-1.33	393.24	-2.07
12/2/2004	394.82	393.55	-1.27	392.88	-1.94
12/3/2004	393.88	392.63	-1.25	392.04	-1.84
12/4/2004	392.94	391.79	-1.15	391.30	-1.65
12/5/2004	391.53	390.49	-1.03	390.14	-1.39
12/6/2004	391.11	390.03	-1.09	389.58	-1.54
12/7/2004	394.30	392.81	-1.49	392.09	-2.21
12/8/2004	397.99	396.30	-1.69	395.37	-2.63
12/9/2004	397.82	396.33	-1.50	395.50	-2.32
12/10/2004	396.99	395.61	-1.38	394.85	-2.14
12/11/2004	395.35	394.11	-1.24	393.56	-1.79
12/12/2004	393.80	392.65	-1.15	392.23	-1.57
12/13/2004	393.04	391.82	-1.22	391.44	-1.60
12/14/2004	392.34	391.23	-1.10	390.84	-1.50
12/15/2004	391.81	390.76	-1.05	390.46	-1.35
12/16/2004	391.41	390.38	-1.03	390.02	-1.39
12/17/2004	390.88	389.94	-0.94	389.71	-1.17
12/18/2004	389.88	388.96	-0.93	388.75	-1.13
12/19/2004	389.92	388.98	-0.95	388.68	-1.24
12/20/2004	388.88	388.04	-0.84	387.83	-1.05
12/21/2004	388.37	387.50	-0.86	387.30	-1.07
12/22/2004	387.32	386.61	-0.71	386.43	-0.89
12/23/2004	385.08	384.57	-0.52	384.44	-0.64
12/24/2004	383.40	383.03	-0.37	382.95	-0.45
12/25/2004	383.65	383.04	-0.61	382.99	-0.66
12/26/2004	384.12	383.53	-0.59	383.35	-0.77
12/27/2004	383.99	383.34	-0.65	383.20	-0.79
12/28/2004	384.06	383.44	-0.62	383.30	-0.76
12/29/2004	383.70	383.00	-0.70	382.90	-0.80
12/30/2004	383.53	382.94	-0.59	382.86	-0.67
12/31/2004	382.70	382.15	-0.55	382.03	-0.68
		Maximum	**-1.69**		**-2.63**
		Average	**-0.98**		**-1.34**
		Minimum	**-0.37**		**-0.45**

TABLE 9
COMPARISON OF PZ-2 OUTSIDE AND PZ-3 OUTSIDE GROUNDWATER LEVELS TO SURFACE WATER LEVELS

Sauget Area 2 Groundwater Migration Control System
Interim Operating Period 1 - December 2004 and January and February 2005
Sauget and Cahokia, Illinois

January	SWL (feet NGVD)	PZ- 2 O (feet)	Delta (feet)	PZ-3 O (feet)	Delta (feet)
1/1/2005	383.08	382.41	-0.67	382.35	-0.73
1/2/2005	382.25	381.69	-0.56	381.63	-0.62
1/3/2005	385.14	384.29	-0.85	384.05	-1.09
1/4/2005	391.60	390.03	-1.57	389.39	-2.21
1/5/2005	401.15	398.91	-2.23	397.47	-3.67
1/6/2005	408.18	405.58	-2.61	403.60	-4.59
1/7/2005	408.37	405.90	-2.47	404.04	-4.33
1/8/2005	404.28	402.26	-2.02	400.88	-3.40
1/9/2005	401.78	399.98	-1.80	398.88	-2.90
1/10/2005	399.53	398.01	-1.52	397.15	-2.38
1/11/2005	397.77	396.38	-1.39	395.70	-2.07
1/12/2005	396.81	395.49	-1.32	394.87	-1.95
1/13/2005	400.00	398.18	-1.82	397.24	-2.77
1/14/2005	405.15	402.95	-2.20	401.62	-3.53
1/15/2005	405.04	403.01	-2.03	401.76	-3.28
1/16/2005	401.78	400.06	-1.71	399.17	-2.60
1/17/2005	400.17	NA	NA	397.96	-2.21
1/18/2005	NA	394.56	NA	394.83	NA
1/19/2005	NA	395.15	NA	394.04	NA
1/20/2005	395.76	NA	NA	394.40	-1.36
1/21/2005	395.49	394.02	-1.47	394.13	-1.37
1/22/2005	395.31	393.83	-1.48	393.76	-1.55
1/23/2005	392.86	393.04	0.18	393.13	0.28
1/24/2005	393.76	392.45	-1.31	392.66	-1.10
1/25/2005	393.77	392.50	-1.27	392.62	-1.15
1/26/2005	393.26	392.00	-1.26	392.15	-1.11
1/27/2005	392.58	391.34	-1.24	391.53	-1.05
1/28/2005	391.90	390.70	-1.20	390.90	-0.99
1/29/2005	391.81	390.61	-1.20	390.78	-1.04
1/30/2005	391.65	390.48	-1.17	390.66	-1.00
1/31/2005	391.36	390.20	-1.17	390.35	-1.01
		Maximum	**-2.61**		**-4.59**
		Average	**-1.46**		**-1.96**
		Minimum	**0.18**		**0.28**

TABLE 9
COMPARISON OF PZ-2 OUTSIDE AND PZ-3 OUTSIDE GROUNDWATER LEVELS TO SURFACE WATER LEVELS

Sauget Area 2 Groundwater Migration Control System
Interim Operating Period 1 - December 2004 and January and February 2005
Sauget and Cahokia, Illinois

February	SWL (feet NGVD)	PZ- 2 O (feet)	Delta (feet)	PZ-3 O (feet)	Delta (feet)
2/1/2005	390.95	389.82	-1.13	390.01	-0.94
2/2/2005	390.19	389.25	-0.95	389.55	-0.64
2/3/2005	389.55	388.74	-0.82	389.18	-0.38
2/4/2005	389.27	388.46	-0.81	388.82	-0.45
2/5/2005	389.00	388.12	-0.88	388.44	-0.56
2/6/2005	389.08	388.23	-0.84	388.50	-0.57
2/7/2005	389.63	388.71	-0.92	388.93	-0.70
2/8/2005	391.27	390.18	-1.09	390.35	-0.93
2/9/2005	391.65	390.55	-1.10	390.71	-0.94
2/10/2005	392.49	391.27	-1.22	391.38	-1.11
2/11/2005	393.61	392.30	-1.32	392.38	-1.24
2/12/2005	393.60	392.27	-1.34	392.38	-1.23
2/13/2005	393.75	392.33	-1.43	392.42	-1.33
2/14/2005	397.57	395.81	-1.76	395.71	-1.86
2/15/2005	401.59	399.62	-1.97	399.23	-2.36
2/16/2005	403.72	401.65	-2.07	401.12	-2.60
2/17/2005	403.60	401.58	-2.03	401.10	-2.50
2/18/2005	402.58	400.66	-1.92	400.29	-2.28
2/19/2005	401.83	400.00	-1.83	399.74	-2.09
2/20/2005	400.72	399.00	-1.71	398.88	-1.83
2/21/2005	399.27	397.72	-1.55	397.68	-1.59
2/22/2005	397.80	396.30	-1.50	394.60	-3.20
2/23/2005	397.18	395.72	-1.46	395.72	-1.46
2/24/2005	396.13	394.74	-1.39	394.61	-1.52
2/25/2005	394.76	393.43	-1.33	393.30	-1.46
2/26/2005	393.65	392.33	-1.32	392.39	-1.27
2/27/2005	393.34	392.08	-1.26	392.15	-1.19
2/28/2005	392.77	391.53	-1.24	391.63	-1.14
		Maximum	**-2.07**		**-3.20**
		Average	**-1.36**		**-1.41**
		Minimum	**-0.81**		**-0.38**

Notes:
SWL = Surface water level

TABLE 10
PUMPING RATES AND GROUNDWATER GRADIENTS DURING AVERAGE HIGH, AVERAGE, AND LOW SURFACE WATER LEVELS (± 1 FOOT)

Sauget Area 2 Groundwater Migration Control System
Interim Operating Period 1 - December 2004 and January and February 2005
Sauget and Cahokia, Illinois

Data for Days with Average SWL within ± 1 ft. of High Monthly Average Mississippi River Stage (401 feet NGVD)

MODFLOW Predicted Pumping Rate = 300 gpm

Day	Date	SWL (feet NGVD)	B-21B GWL (feet)	PZ-1 Outside GWL (feet)	Gradient Across Site R (feet/feet)	Darcy Flow into Barrier Wall (gpm)	Actual Flow Out of Barrier Wall (gpm)	Amount of Under/Over Pumping (gpm)	PZ - 1 Gradient (feet)	PZ - 2 Gradient (feet)	PZ - 3 Gradient (feet)	PZ - 4 Gradient (feet)
1	5-Jan-05	401.15	389.37	394.77	-0.010	0	5	5	-7.16	-9.61	-8.26	-4.89
2	9-Jan-05	401.78	393.32	397.30	-0.0075	0	119	119	-6.35	-7.40	-6.34	-4.45
3	13-Jan-05	400.00	393.92	396.45	-0.0048	0	343	343	-5.56	-5.59	-5.11	-3.81
4	16-Jan-05	401.78	396.07	398.33	-0.0043	0	3	3	-4.85	-4.91	-4.30	-3.15
5	17-Jan-05	400.17	396.26	397.89	-0.0031	0	9	9	NA	NA	-3.01	-2.32
6	15-Feb-05	401.59	NA	397.70	-0.013	0	13	13	-4.49	-5.09	-4.89	-2.67
7	19-Feb-05	401.83	NA	398.66	-0.011	0	13	13	-3.82	-3.89	-3.87	-1.85
8	20-Feb-05	400.72	NA	398.20	-0.0084	0	13	13	-3.02	-2.54	-2.77	-1.30
Maximum		**401.83**	**396.26**	**398.66**	**-0.0130**	**0**	**343**	**343**	**-7.16**	**-9.61**	**-8.26**	**-4.89**
Average		**401.13**	**393.79**	**397.41**	**-0.0077**	**0**	**65**	**65**	**-5.04**	**-5.58**	**-4.82**	**-3.06**
Minimum		**400.00**	**389.37**	**394.77**	**-0.003**	**0**	**3**	**3**	**-3.02**	**-2.54**	**-2.77**	**-1.30**

TABLE 10
PUMPING RATES AND GROUNDWATER GRADIENTS DURING AVERAGE HIGH, AVERAGE, AND LOW SURFACE WATER LEVELS (± 1 FOOT)

Sauget Area 2 Groundwater Migration Control System
Interim Operating Period 1 - December 2004 and January and February 2005
Sauget and Cahokia, Illinois

Data for Days with Average SWL within ± 1 ft. of Average Monthly Average Mississippi River Stage (391 feet NGVD)

MODFLOW Predicted Pumping Rate = 535 gpm

Day	Date	SWL (feet NGVD)	B-21B GWL (feet)	PZ-1 Outside GWL (feet)	Gradient Across Site R (feet/feet)	Darcy Flow into Barrier Wall (gpm)	Actual Flow Out of Barrier Wall (gpm)	Amount of Under/Over Pumping (gpm)	PZ - 1 Gradient (feet)	PZ - 2 Gradient (feet)	PZ - 3 Gradient (feet)	PZ - 4 Gradient (feet)
1	5-Dec-04	391.53	391.36	390.89	0.00088	262	599	337	-2.80	-0.77	-1.28	-1.30
2	6-Dec-04	391.11	391.05	390.57	0.00091	270	1,097	827	-3.33	-1.50	-2.14	-2.00
3	15-Dec-04	391.81	392.13	391.38	0.0014	417	861	444	-3.38	-0.84	-0.93	-1.04
4	16-Dec-04	391.41	391.65	391.09	0.0011	314	1,218	904	-4.46	-1.68	-1.52	-1.60
5	17-Dec-04	390.88	391.67	390.82	0.0016	474	856	381	-3.36	-0.50	-0.65	-0.94
6	4-Jan-05	391.60	388.47	389.44	-0.0018	0	994	994	-4.27	-3.30	-3.35	-2.18
7	28-Jan-05	391.90	394.46	392.50	0.0037	1,095	1,264	169	-1.41	0.95	-1.20	-0.97
8	29-Jan-05	391.81	394.37	392.40	0.0037	1,098	1,253	155	-1.42	0.96	-1.20	-0.97
9	30-Jan-05	391.65	394.24	392.26	0.0037	1,107	1,246	139	-1.41	0.98	-1.21	-0.95
10	31-Jan-05	391.36	394.06	392.02	0.0039	1,142	1,270	128	-1.42	1.01	-1.11	-0.95
11	1-Feb-05	390.95	NA	391.72	0.0026	765	1,481	716	-2.36	0.55	-1.08	-0.94
12	2-Feb-05	390.19	NA	391.34	0.0038	1,135	594	-541	-1.23	2.42	1.26	0.69
13	8-Feb-05	391.27	NA	391.45	0.00060	177	1,174	997	-3.52	-0.37	-0.95	-0.67
14	9-Feb-05	391.65	NA	391.72	0.00024	70	1,116	1,046	-3.38	-0.43	-1.02	-0.66
Maximum		**391.90**	**394.46**	**392.50**	**0.0039**	**1,142**	**1,481**	**1,046**	**-4.46**	**-3.30**	**-3.35**	**-2.18**
Average		**391.37**	**392.35**	**391.40**	**0.0019**	**595**	**1,073**	**478**	**-2.70**	**-0.18**	**-1.17**	**-1.03**
Minimum		**390.19**	**388.47**	**389.44**	**-0.0018**	**0**	**594**	**-541**	**-1.23**	**-0.37**	**-0.65**	**-0.66**

TABLE 10
PUMPING RATES AND GROUNDWATER GRADIENTS DURING AVERAGE HIGH, AVERAGE, AND LOW SURFACE WATER LEVELS (± 1 FOOT)

Sauget Area 2 Groundwater Migration Control System
Interim Operating Period 1 - December 2004 and January and February 2005
Sauget and Cahokia, Illinois

Data for Days with Average SWL within ± 1 ft. of Low Monthly Average Mississippi River Stage (383 feet NGVD)

MODFLOW Predicted Pumping Rate = 725 gpm

Day	Date	SWL (feet NGVD)	B-21B GWL (feet)	PZ-1 Outside GWL (feet)	Gradient Across Site R (feet/feet)	Darcy Flow into Barrier Wall (gpm)	Actual Flow Out of Barrier Wall (gpm)	Amount of Under/Over Pumping (gpm)	PZ - 1 Gradient (feet)	PZ - 2 Gradient (feet)	PZ - 3 Gradient (feet)	PZ - 4 Gradient (feet)
1	24-Dec-04	383.40	389.14	386.10	0.0057	1,698	2,174	475	-3.41	1.80	0.54	-1.16
2	25-Dec-04	383.65	388.84	386.03	0.0053	1,570	2,171	600	-3.55	1.58	0.31	-1.22
3	27-Dec-04	383.99	388.25	386.00	0.0043	1,259	2,170	911	-4.09	0.72	-0.40	-1.59
4	29-Dec-04	383.70	387.91	385.70	0.0042	1,235	2,163	929	-4.00	0.80	-0.40	-1.60
5	30-Dec-04	383.53	387.80	385.58	0.0042	1,243	2,162	919	-4.00	0.77	-0.37	-1.60
6	31-Dec-04	382.70	387.52	384.99	0.0048	1,412	2,161	749	-3.71	1.25	0.11	-1.33
7	1-Jan-05	383.08	387.35	385.13	0.0042	1,241	2,162	922	-4.02	0.85	-0.30	-1.55
8	2-Jan-05	382.25	387.17	384.59	0.0049	1,443	2,160	718	-3.61	1.44	0.22	-1.22
Maximum		**383.99**	**389.14**	**386.10**	**0.0057**	**1,698**	**2,174**	**929**	**-4.09**	**1.80**	**0.54**	**-1.60**
Average		**383.29**	**388.00**	**385.51**	**0.0047**	**1,388**	**2,166**	**778**	**-3.80**	**1.15**	**-0.04**	**-1.41**
Minimum		**382.25**	**387.17**	**384.59**	**0.0042**	**1,235**	**2,160**	**475**	**-3.41**	**0.72**	**0.11**	**-1.16**

Notes:
gpm = Gallons per minute
SWL = Surface water level

TABLE 11
COMPARISON OF AVERAGE GRADIENTS ACROSS BARRIER WALL TO SYSTEM PUMPING RATES

Sauget Area 2 Groundwater Migration Control System
Interim Operating Period 1 - December 2004 and January and February 2005
Sauget and Cahokia, Illinois

Date	Q (gpm)	Head Across Wall (feet)	CC
1-Dec-04	196	-3.21	
2-Dec-04	239	-2.97	
3-Dec-04	319	-2.62	
4-Dec-04	450	-2.26	
5-Dec-04	599	-1.53	**1.00**
6-Dec-04	1,097	-2.24	
7-Dec-04	668	-3.59	
8-Dec-04	156	-4.67	
9-Dec-04	29	-3.97	
10-Dec-04	20	-3.27	
11-Dec-04	14	-2.15	
12-Dec-04	365	-1.65	**0.31**
13-Dec-04	592	-1.90	
14-Dec-04	722	-1.69	
15-Dec-04	861	-1.55	
16-Dec-04	1,218	-2.32	
17-Dec-04	856	-1.36	
18-Dec-04	1,445	-1.81	
19-Dec-04	1,391	-2.07	**-0.48**
20-Dec-04	1,802	-2.27	
21-Dec-04	1,738	-2.09	
22-Dec-04	1,870	-1.82	
23-Dec-04	2,164	-1.42	
24-Dec-04	2,174	-0.56	
25-Dec-04	2,171	-0.72	
26-Dec-04	2,169	-1.33	**0.88**
27-Dec-04	2,170	-1.34	
28-Dec-04	2,170	-1.42	
29-Dec-04	2,163	-1.30	
30-Dec-04	2,162	-1.30	
31-Dec-04	2,161	-0.92	
1-Jan-05	2,162	-1.26	
2-Jan-05	2,160	-0.79	**-0.71**
3-Jan-05	791	-0.14	
4-Jan-05	994	-3.27	
5-Jan-05	5	-7.48	
6-Jan-05	191	-11.64	
7-Jan-05	120	-11.37	
8-Jan-05	180	-8.23	
9-Jan-05	119	-6.14	**0.76**
10-Jan-05	257	-4.77	
11-Jan-05	153	-3.35	
12-Jan-05	521	-3.31	
13-Jan-05	343	-5.02	
14-Jan-05	20	-7.11	
15-Jan-05	3	-6.63	
16-Jan-05	3	-4.30	**0.59**
17-Jan-05	9	-2.66	
18-Jan-05	180	0.19	
19-Jan-05	571	-1.12	
20-Jan-05	802	-1.78	
21-Jan-05	965	-3.44	
22-Jan-05	1,130	-1.72	
23-Jan-05	885	-1.20	**-0.26**
24-Jan-05	1,054	-1.08	
25-Jan-05	1,071	-1.16	
26-Jan-05	1,122	-1.21	
27-Jan-05	1,175	-0.86	
28-Jan-05	1,264	-0.66	
29-Jan-05	1,253	-0.66	
30-Jan-05	1,246	-0.65	**0.93**
31-Jan-05	1,270	-0.61	
1-Feb-05	1,481	-0.96	
2-Feb-05	594	0.79	
3-Feb-05	0	3.01	
4-Feb-05	918	1.59	
5-Feb-05	1,956	-1.12	
6-Feb-05	1,893	-1.26	**-0.94**
7-Feb-05	1,682	-1.34	
8-Feb-05	1,174	-1.38	
9-Feb-05	1,116	-1.37	
10-Feb-05	876	-1.41	
11-Feb-05	642	-1.38	
12-Feb-05	777	-1.38	
13-Feb-05	772	-1.40	**0.75**
14-Feb-05	45	-2.23	
15-Feb-05	13	-4.29	
16-Feb-05	13	-5.40	
17-Feb-05	-11	-4.98	
18-Feb-05	13	-4.07	
19-Feb-05	13	-3.36	
20-Feb-05	13	-2.41	**0.66**
21-Feb-05	55	-1.63	
22-Feb-05	400	-0.99	
23-Feb-05	544	-1.41	
24-Feb-05	821	-1.30	
25-Feb-05	1,116	-1.27	
26-Feb-05	1,327	-1.31	
27-Feb-05	1,354	-1.32	**0.26**
28-Feb-05	1,459	-1.30	

NOTES:
1. Pumps off for actuator valve installation on February 2, 3 and 4, 2005.
   CC = Correlation Coefficient

TABLE 12
COMPARISON OF AVERAGE GRADIENTS ACROSS SITE R TO RIVER STAGE AND SYSTEM PUMPING RATE

Sauget Area 2 Groundwater Migration Control System
Interim Operating Period 1 - December 2004 and January and February 2005
Sauget and Cahokia, Illinois

Date	Average Gradient Across Site R (feet)	SWL (feet NGVD)	Pumping Rate (gpm)	Gradient vs. SWL CC	Gradient vs. Q CC
1-Dec-04	-0.0031	395.31	196		
2-Dec-04	-0.0022	394.82	239		
3-Dec-04	-0.0013	393.88	319		
4-Dec-04	-0.00043	392.94	450		
5-Dec-04	0.00094	391.53	599	**-0.99**	**0.99**
6-Dec-04	0.00083	391.11	1,097		
7-Dec-04	-0.0022	394.30	668		
8-Dec-04	-0.0050	397.99	156		
9-Dec-04	-0.0041	397.82	29		
10-Dec-04	-0.0031	396.99	20		
11-Dec-04	-0.0013	395.35	14		
12-Dec-04	0.00050	393.80	365	**-0.92**	**0.63**
13-Dec-04	0.00044	393.04	592		
14-Dec-04	0.0011	392.34	722		
15-Dec-04	0.0017	391.81	861		
16-Dec-04	0.0013	391.41	1,218		
17-Dec-04	0.0019	390.88	856		
18-Dec-04	0.0026	389.88	1,445		
19-Dec-04	0.0018	389.92	1,391	**-0.90**	**0.75**
20-Dec-04	0.0027	388.88	1,802		
21-Dec-04	0.0025	388.37	1,738		
22-Dec-04	0.0032	387.32	1,870		
23-Dec-04	0.0045	385.08	2,164		
24-Dec-04	0.0058	383.40	2,174		
25-Dec-04	0.0054	383.65	2,171		
26-Dec-04	0.0044	384.12	2,169	**-0.97**	**0.98**
27-Dec-04	0.0044	383.99	2,170		
28-Dec-04	0.0043	384.06	2,170		
29-Dec-04	0.0044	383.70	2,163		
30-Dec-04	0.0044	383.53	2,162		
31-Dec-04	0.0050	382.70	2,161		

NOTES:
1. Excluded Q data; flow constant at maximum system capacity.
2. Excluded south gradient; PZ-4 Outside GWL data suspect.
CC = Correlation Coefficient

TABLE 12
COMPARISON OF AVERAGE GRADIENTS ACROSS SITE R TO RIVER STAGE AND SYSTEM PUMPING RATE

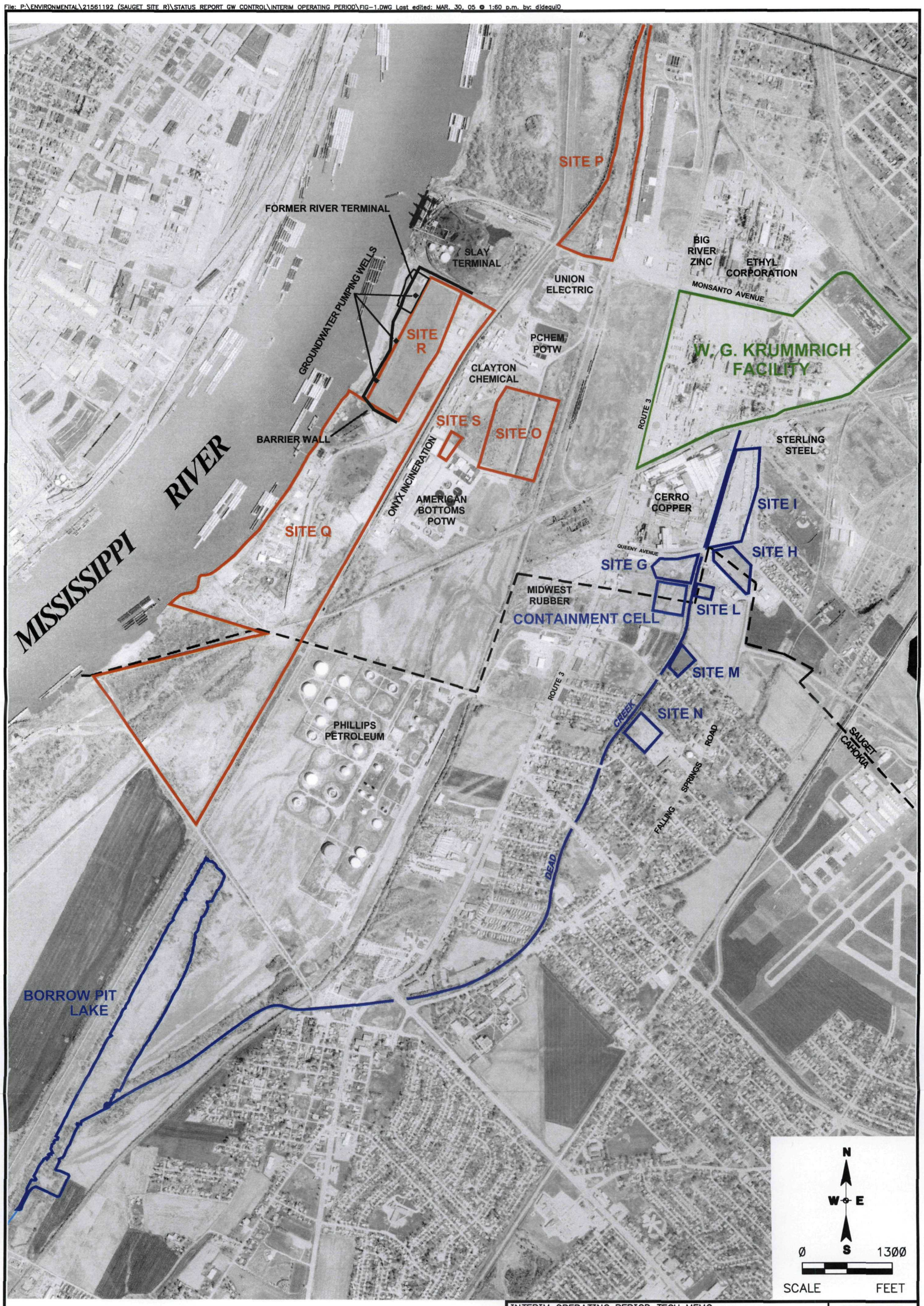
Sauget Area 2 Groundwater Migration Control System
Interim Operating Period 1 - December 2004 and January and February 2005
Sauget and Cahokia, Illinois

Date	Average Gradient Across Site R (feet)	SWL (feet NGVD)	Pumping Rate (gpm)	Gradient vs. SWL CC	Gradient vs. Q CC
1-Jan-2005	0.0044	383.08	2,162		
2-Jan-2005	0.0051	382.25	2,160	**-0.88**	**NA**
3-Jan-2005	0.0032	385.14	791		
4-Jan-2005	-0.0011	391.60	994		
5-Jan-2005	-0.0094	401.15	5		
6-Jan-2005	-0.016	408.18	191		
7-Jan-2005	-0.016	408.37	120		
8-Jan-2005	-0.011	404.28	180		
9-Jan-2005	-0.0077	401.78	119	**-0.99**	**0.81**
10-Jan-2005	-0.0051	399.53	257		
11-Jan-2005	-0.0029	397.77	153		
12-Jan-2005	-0.0017	396.81	521		
13-Jan-2005	-0.0050	400.00	343		
14-Jan-2005	-0.0090	405.15	20		
15-Jan-2005	-0.0081	405.04	3		
16-Jan-2005	-0.0044	401.78	3	**-0.95**	**0.69**
17-Jan-2005	-0.0028	400.17	9		
18-Jan-2005	-0.00077	NA	180		
19-Jan-2005	0.00019	NA	571		
20-Jan-2005	0.0013	395.76	802		
21-Jan-2005	0.0013	395.49	965		
22-Jan-2005	0.0014	395.31	1,130		
23-Jan-2005	0.0021	392.86	885	**-1.00**	**0.92**
24-Jan-2005	0.0027	393.76	1,054		
25-Jan-2005	0.0026	393.77	1,071		
26-Jan-2005	0.0027	393.26	1,122		
27-Jan-2005	0.0031	392.58	1,175		
28-Jan-2005	0.0037	391.90	1,264		
29-Jan-2005	0.0037	391.81	1,253		
30-Jan-2005	0.0037	391.65	1,246	**-0.98**	**0.97**
31-Jan-2005	0.0037	391.36	1,270		

NOTES:
1. Excluded Q data; flow constant at maximum system capacity.
2. Excluded south gradient; PZ-4 Outside GWL data suspect.
CC = Correlation Coefficient

Figures

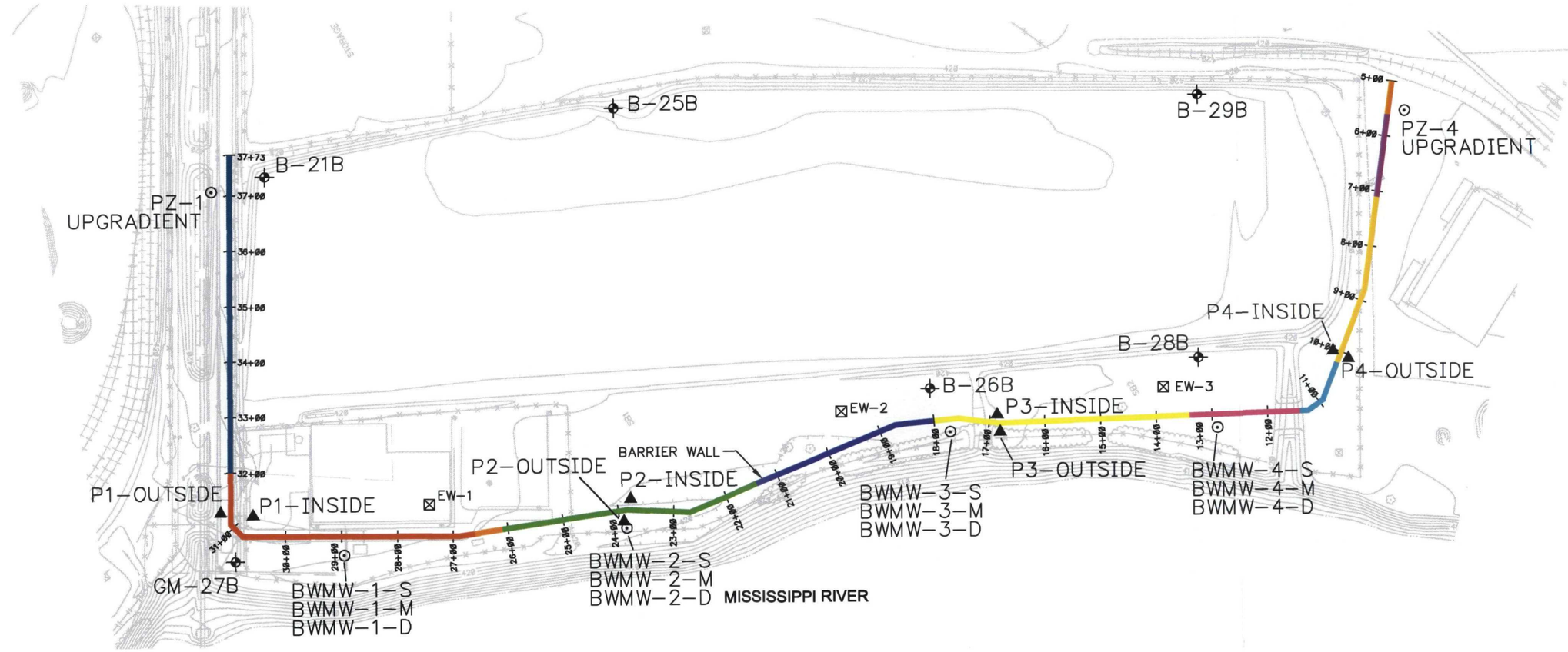
File: P:\ENVIRONMENTAL\21561192 (SAUGET SITE R)\STATUS REPORT GW CONTROL\INTERIM OPERATING PERIOD\FIG-1.DWG Last edited: MAR. 30, 05 @ 1:60 p.m. by: djdequi0



LEGEND

- W.G. KRUMMRICH FACILITY
- SAUGET AREA #1
- SAUGET AREA #2

INTERIM OPERATING PERIOD TECH MEMO GROUNDWATER MIGRATION CONTROL SYSTEM SAUGET AREA 2 SAUGET & CAHOKIA, ILLINOIS		PROJECT NO. 21561388.00000
URS		
DRN. BY: djd 3/29/05 DSGN. BY: jg CHKD. BY:	Site Location Map	FIG. NO. 1



LEGEND (2003)

- OCTOBER
- NOVEMBER
- DECEMBER

LEGEND (2004)

- JANUARY
- APRIL
- MAY
- JUNE
- JULY
- AUGUST
- SEPTEMBER

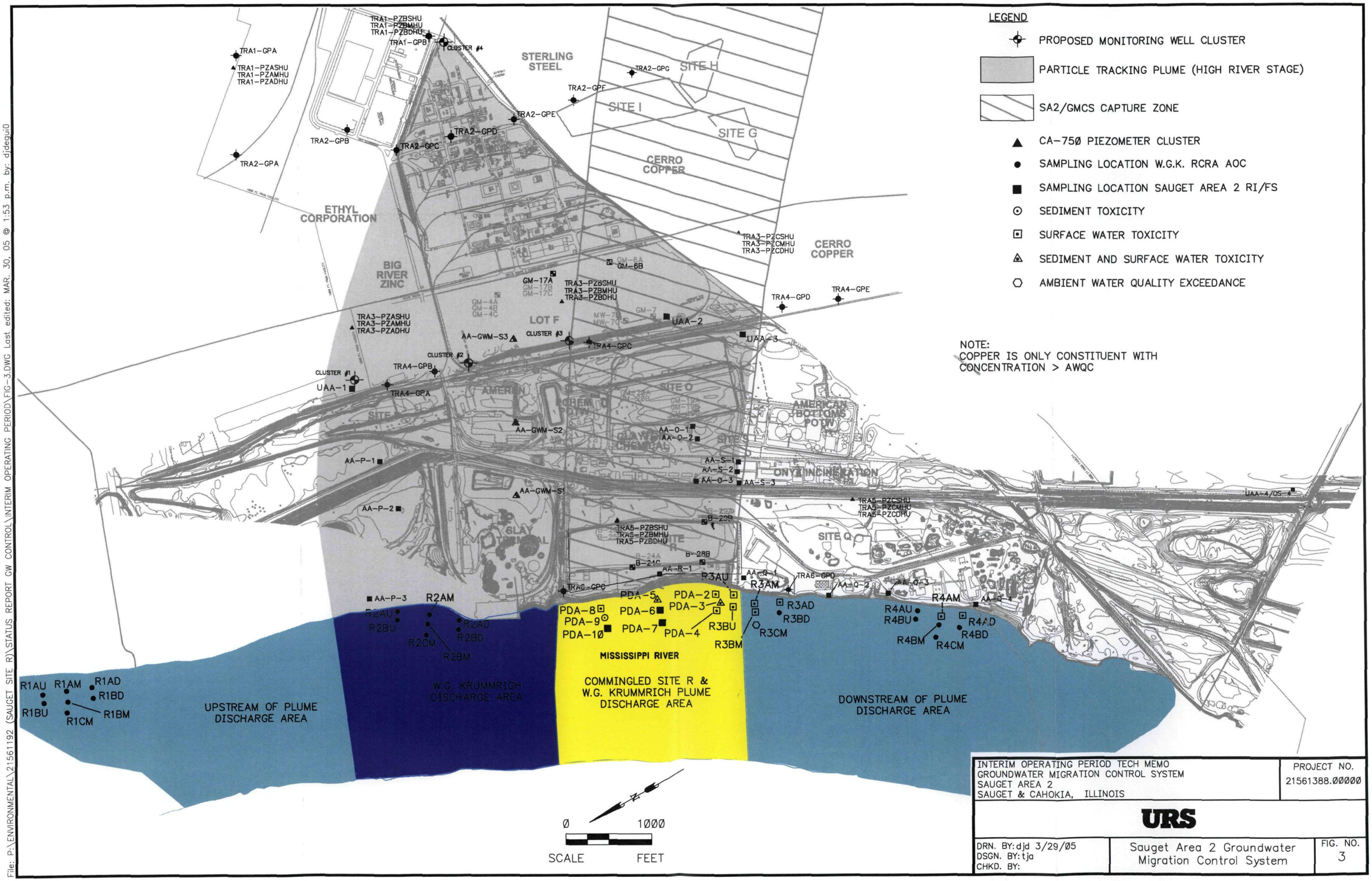
Ø 200

SCALE FEET

INTERIM OPERATING PERIOD TECH MEMO GROUNDWATER MIGRATION CONTROL SYSTEM SAUGET AREA 2 SAUGET & CAHOKIA, ILLINOIS	PROJECT NO. 21561388.00000
URS	
DRN. BY: djd 3/29/05 DSGN. BY: jg CHKD. BY:	**Barrier Wall, Monitoring Well and Groundwater Level Location Map** — FIG. NO. 2

File: P:\ENVIRONMENTAL\21561192 (SAUGET SITE 4)\STATUS REPORT GW CONTROL\INTERIM OPERATING PERIOD\DGC-2.DWG Last edited: 03/30/05 @ 1:58 p.m. WC-ST.LOUIS_MO

File: P:\ENVIRONMENTAL\21561192 (SAUGET SITE R)\STATUS REPORT GW CONTROL\INTERIM OPERATING PERIOD\FIG-3.DWG Last edited: MAR. 30, 05 @ 1:53 p.m. by: djdegui0



INTERIM OPERATING PERIOD TECH MEMO GROUNDWATER MIGRATION CONTROL SYSTEM SAUGET AREA 2 SAUGET & CAHOKIA, ILLINOIS	PROJECT NO. 21561388.00000
URS	
DRN. BY: djd 3/29/05 DSGN. BY: tja CHKD. BY:	Sauget Area 2 Groundwater Migration Control System
	FIG. NO. 3

PZ-1
UPGRADIENT

PZ-5

PZ-6

PZ-7

PZ-8

PZ-9

PZ-4
UPGRADIENT

PZ-10

P4-INSIDE

P4-OUTSIDE

EW-3

EW-2

P3-INSIDE

P3-OUTSIDE

BWMW-3-S
BWMW-3-M
BWMW-3-D

BWMW-4-S
BWMW-4-M
BWMW-4-D

PDA-2

PDA-5

PDA-3

PDA-4

P1-OUTSIDE

P1-INSIDE

EW-1

P2-OUTSIDE

P2-INSIDE

BWMW-1-S
BWMW-1-M
BWMW-1-D

BWMW-2-S
BWMW-2-M
BWMW-2-D

PDA-9

LEGEND

- PROPOSED PIEZOMETERS
- EXTRACTION WELLS
- GROUNDWATER LEVEL PIEZOMETERS
- MONITORING WELL CLUSTERS
- SURFACE WATER AND SEDIMENT SAMPLING STATIONS

Ø 200
SCALE FEET

INTERIM OPERATING PERIOD TECH MEMO GROUNDWATER MIGRATION CONTROL SYSTEM SAUGET AREA 2 SAUGET & CAHOKIA, ILLINOIS	PROJECT NO. 21561388.00000
URS	
DRN. BY: djd 3/29/05 DSGN. BY: jg CHKD. BY:	Monitoring Plan — FIG. NO. 4

File: P:\ENVIRONMENTAL\21561192 (SAUGET SITE 6)\STATUS REPORT ON CONTROL\INTERIM OPERATING PERIOD\TECH-4.DWG, last edited: 03/30/05 @ 1:58 p.m. WC-STLOUIS, MO

Attachments

ATTACHMENT 1

Soil/Bentonite Barrier Wall Permeability

ATTACHMENT 1
SOIL/BENTONITE BARRIER WALL PERMEABILITY
Interim Operating Period Tech Memo

Permiability Measurements
cm/s
Well Permeability
3.33E-09
6.30E-09
1.17E-08
1.16E-08
8.31E-09
1.10E-08
1.10E-08
1.39E-08
1.12E-08
8.52E-09
1.40E-08
9.34E-09
1.41E-08
1.66E-08
1.93E-08
1.20E-08
3.05E-08
1.80E-08
2.36E-08
1.62E-08
1.70E-08
7.33E-09
1.31E-08
1.31E-08
1.31E-08
1.31E-08
8.20E-09
8.66E-09
5.39E-09
2.13E-08
2.50E-08
3.45E-08
3.50E-08
1.38E-08
1.10E-08
2.12E-08
1.27E-08
1.11E-08
1.00E-08
1.28E-08
1.60E-08
1.33E-08
1.46E-08
6.98E-09
1.08E-08
3.27E-09
3.90E-09
8.46E-09
2.56E-08
1.29E-08
1.01E-08
3.93E-08
1.76E-08
1.41E-08
1.80E-08
1.90E-08
9.63E-09
6.72E-09
1.30E-08
1.13E-08
1.13E-08
1.28E-08
1.11E-08
3.36E-08
3.30E-08
2.50E-08
2.31E-08
2.10E-08
3.05E-08
2.04E-08
2.08E-08
1.99E-08
2.00E-08
2.69E-08
2.26E-08
1.49E-08
2.36E-08
2.09E-08
1.12E-08
1.39E-08
1.58E-08
1.64E-08
1.23E-08
1.78E-08
1.59E-08
Geometric Mean Well Permeability
1.45E-08

ATTACHMENT 2

Pumping Rates Needed to Achieve Negative Gradients Across Barrier Wall

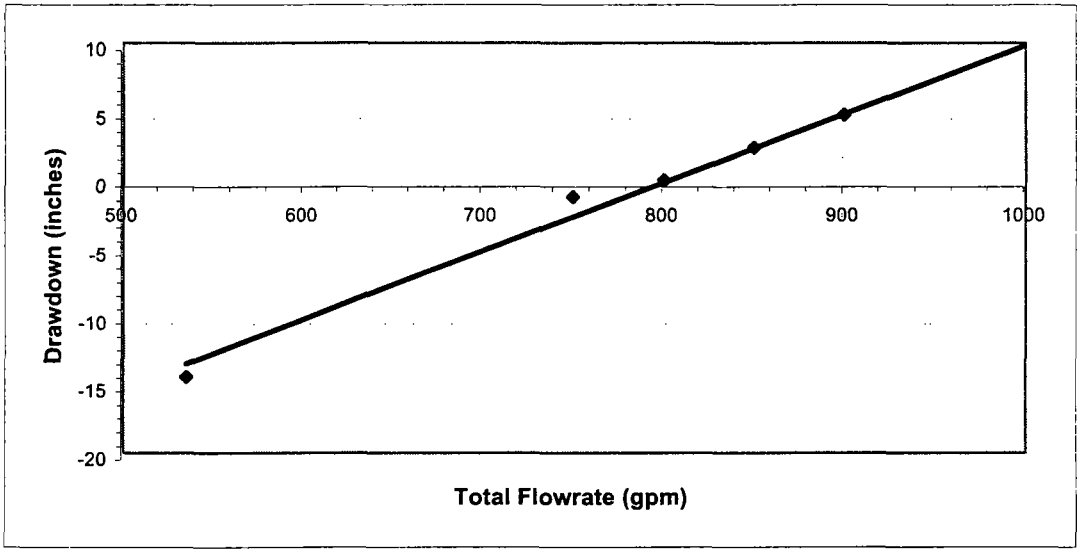
GSI Job No: 2561
Issued: 5/21/03

Preliminary

GROUNDWATER
SERVICES, INC.

Figure 1
DRAWDOWN OBSERVED IN MODFLOW MODEL

Solutia Inc., Sauget Area 2, Sauget, Illinois



NOTES:
- gpm = Gallon per minute

1. *Drawdowns are calculated from MODFLOW and represent the difference in water levels between* piezometers upgradient of the wall and piezometers down gradient of the wall.
2. Four pairs of piezometers were used in the model with each piezometer sampled in each of the three model layers. Drawdown represents the minimum drawdown of the piezometers in layers 2 and 3 only obtained for each flowrate.
3. MODFLOW model based on three wells and an approximately 2000 ft U-shaped barrier wall located downgradient of Site R.
4. Model simulation time is 5 years. River stage is average condition 391 ft-MSL.
5. Results are approximate due to current grid size of model (60 ft by 60 ft).
6. Pumping rates required for the following minimum drawdown are:

Drawdown (in)	Pumping Rate (gpm)	Increase Over Base Case of 535 gpm
2	842	307
4	882	347
6	922	387

ATTACHMENT 3

Effect of Negative Gradients on Pumping Rates from a "U"-Shaped Barrier Wall

GROUNDWATER
SERVICES, INC.

TABLE 1

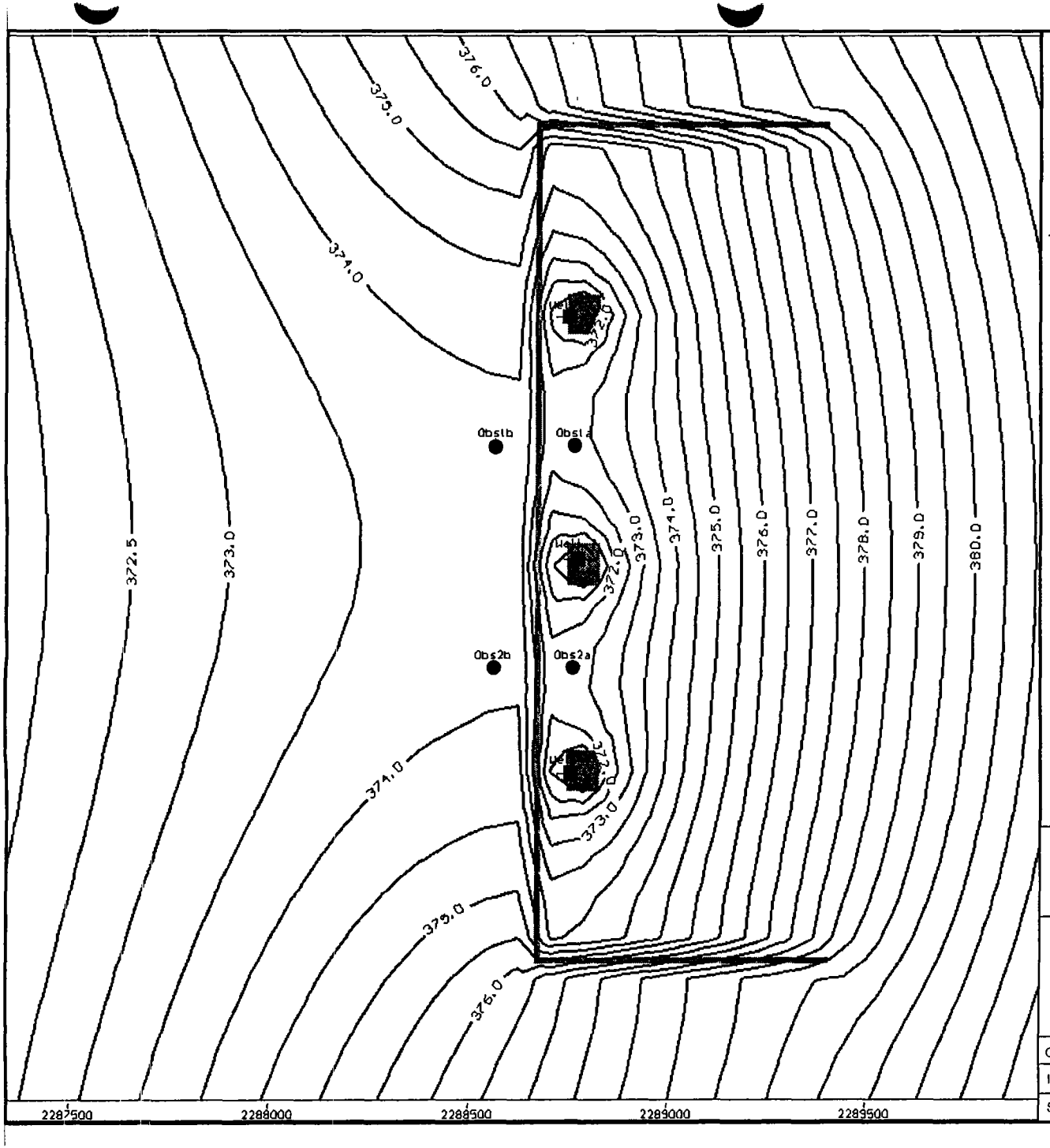
EFFECT OF NEGATIVE GRADIENTS ON PUMPING RATES FROM A U-SHAPED BARRIER WALL

Groundwater Migration Control System
Sauget Area 2, Sauget and Cahokia, Illinois

Case	Inside - Outside Water Level (ft)	Total Flowrate (gpm)	Flowrate ÷ Based Case Flowrate (%)
Base	not applicable	1635	100%
1	-1	2733	167%
2	-2	2910	178%
3	-3	3084	189%
4	-4	3258	199%

Notes:

1. Flowrates obtained from hypothetical Visual Modflow 4.0 model assuming a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 6 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.
2. Observation wells assumed to be located ~ 40 ft apart, located on west end of wall between pumping wells.
   gpm = gallons per minute
   ft = feet
3. Base case: Full capture of incoming groundwater flow into "U" shaped barrier for six foot natural gradient along barrier wingwalls, but no inward gradient requirement (see Case 2, Attachment 5).



N

LEGEND

- 374.0 — Equipotential line
- Observation Well
- Pumping Well

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 6 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

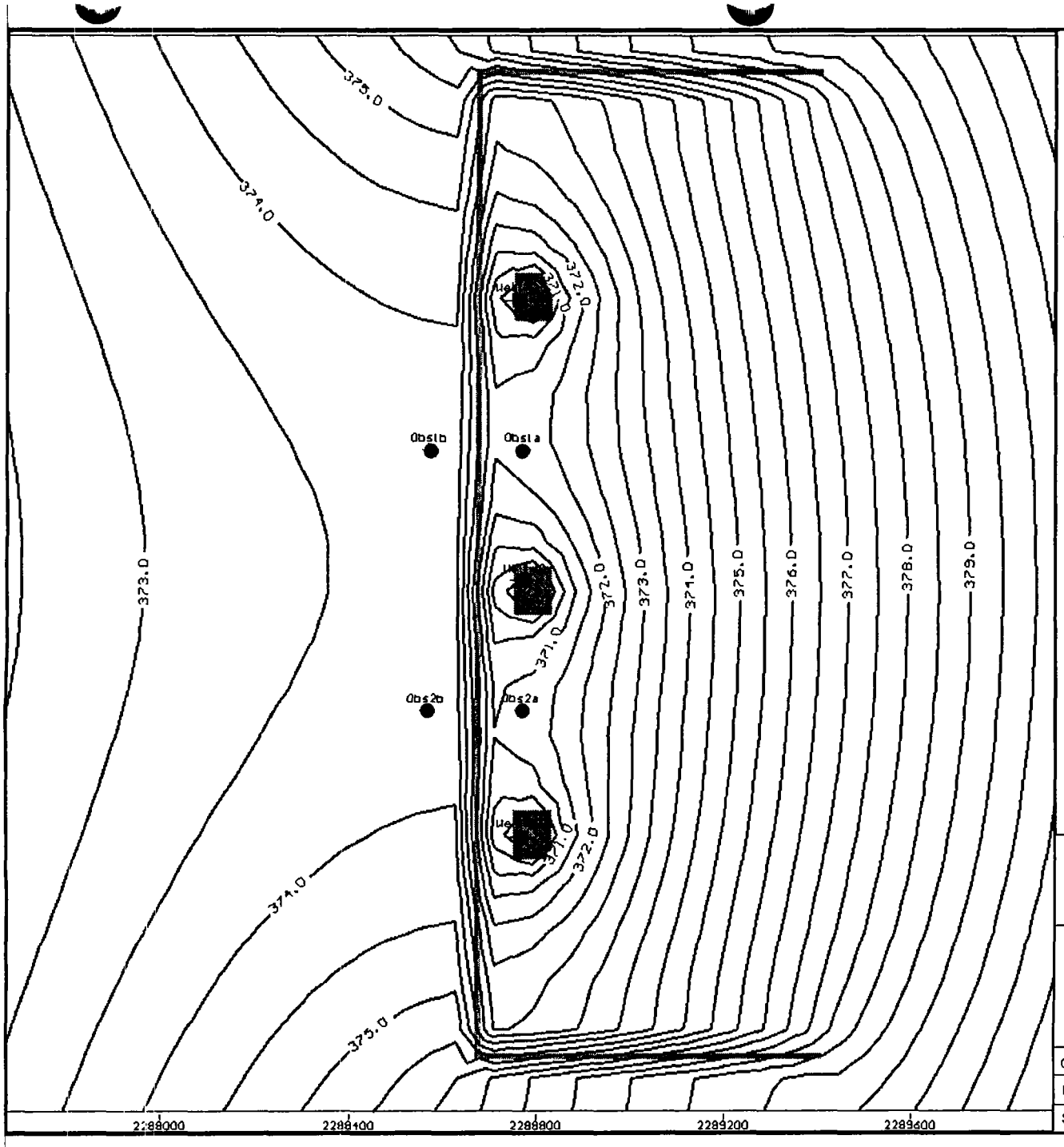
0 500

GROUNDWATER SERVICES, INC.

INWARD NEGATIVE GRADIENT OF 1 FT ACROSS BARRIER (TOTAL Q = 2733 GPM)

Sauget and Cahokia, Illinois

GSI Job No.: G-2898	Drawn by: SKF	**Figure 3.1**
Issued: 04/1/05	Approved by: CJN	
Scale: As Shown	Revised: --	



N

LEGEND

- 374.0 — Equipotential line
- Observation Well
- Pumping Well

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 6 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

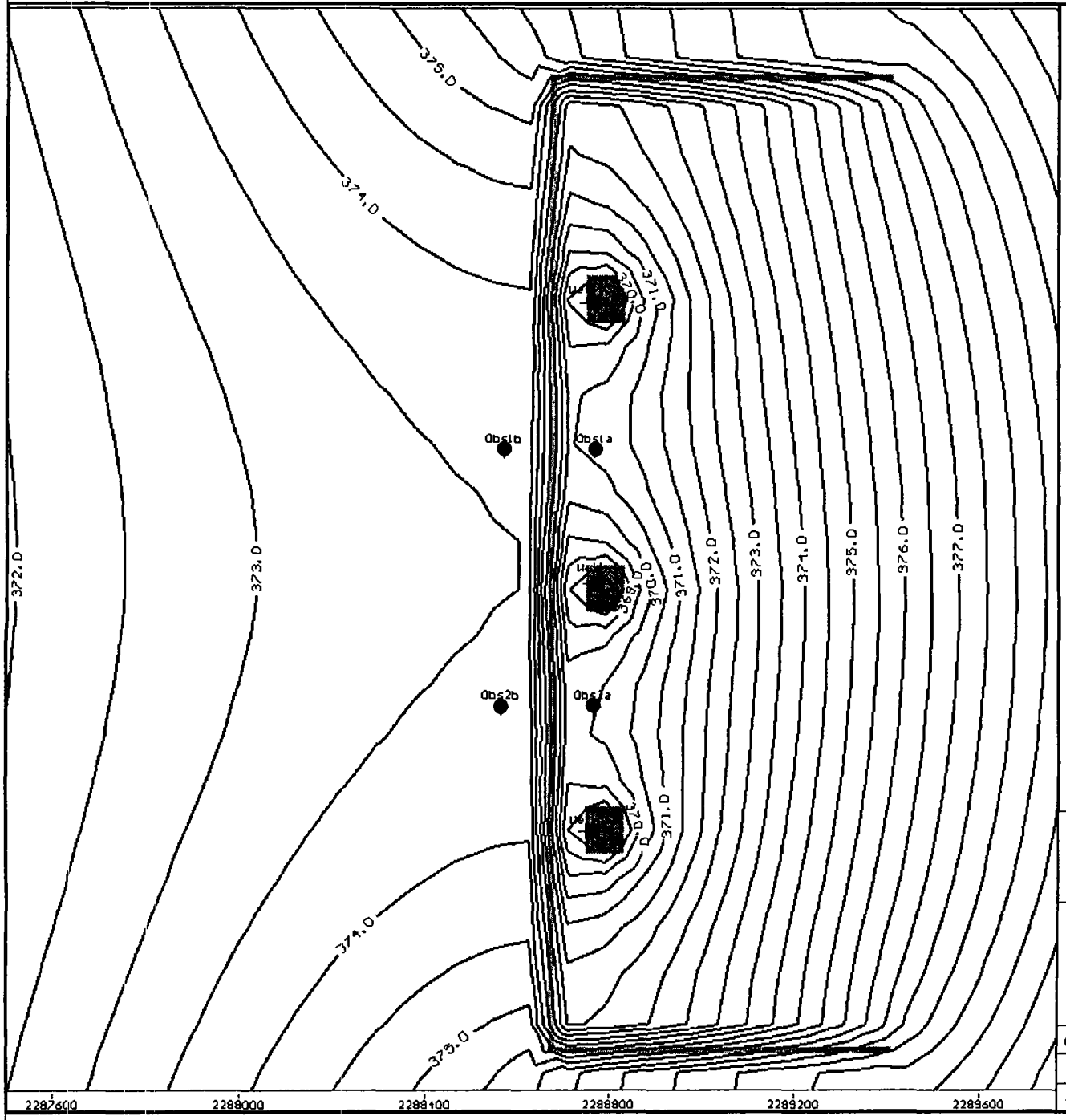
0 500

GROUNDWATER SERVICES, INC.

INWARD NEGATIVE GRADIENT OF 2 FT ACROSS BARRIER (TOTAL Q = 2910 GPM)

Sauget and Cahokia, Illinois

GSI Job No.: G-2898	Drawn by: SKF	**Figure 3.2**
Issued: 04/1/05	Approved by: CJN	
Scale: As Shown	Revised: --	



N

LEGEND

- 374.0 — Equipotential line
- Observation Well
- Pumping Well

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 6 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

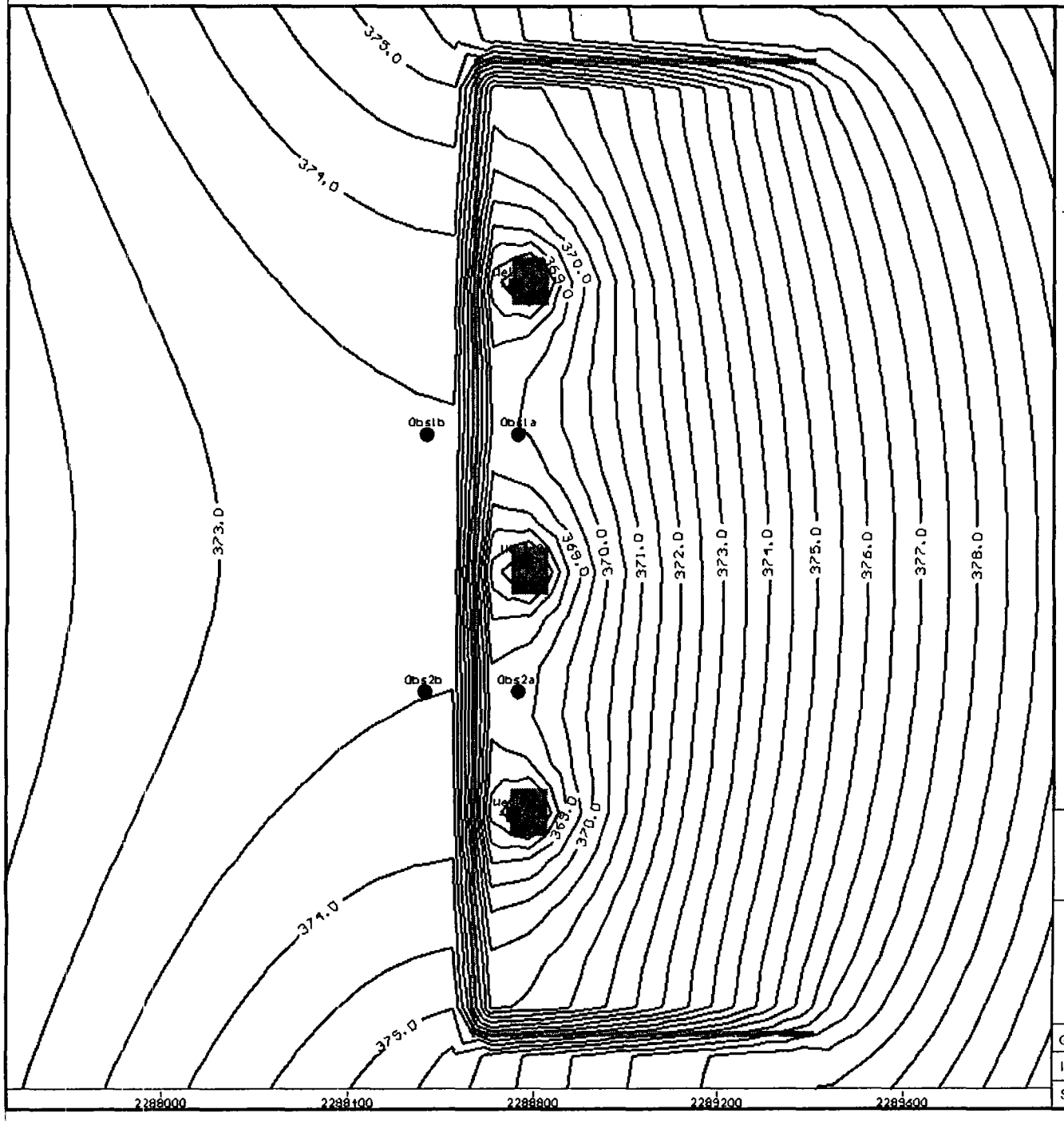
0 500

GROUNDWATER SERVICES, INC.

INWARD NEGATIVE GRADIENT OF 3 FT ACROSS BARRIER (TOTAL Q = 3084 GPM)

Sauget and Cahokia, Illinois

GSI Job No.: G-2898	Drawn by: SKF	**Figure 3.3**
Issued: 02/1/05	Approved by: CJN	
Scale: As Shown	Revised: --	



N

LEGEND

- 374.0 — Equipotential line
- Observation Well
- Pumping Well

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 6 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

0 500

GROUNDWATER SERVICES, INC.

INWARD NEGATIVE GRADIENT OF 4 FT ACROSS BARRIER (TOTAL Q = 3258 GPM)

Sauget and Cahokia, Illinois

GSI Job No.: G-2898	Drawn by: SKF	**Figure 3.4**
Issued: 02/1/05	Approved by: CJN	
Scale: As Shown	Revised: --	

ATTACHMENT 4

Effect of Pumping Rates on Flow Lines at a "U"-Shaped Barrier Wall

ATTACHMENT 4
OBSERVED HYDRAULIC GRADIENT ACROSS SITE R
Interim Operating Period Tech Memo

Date	River Stage Average Level	B-21B	B-21B Minus River ("Gradient Across Site R"
2/11/04	378.72		
2/12/04	379.00	382.87	3.87
2/13/04	378.76		
2/14/04	379.58		
2/15/04	379.28		
2/16/04	378.96	382.67	3.71
2/17/04	378.39	382.77	4.38
2/18/04	378.08		
2/19/04	378.24	382.67	4.43
2/20/04	378.80	382.67	3.87
2/21/04	380.83		
2/22/04	381.93		
2/23/04	383.36	382.87	-0.49
2/24/04	384.93	382.97	-1.95
2/25/04	384.50	383.37	-1.13
2/26/04	386.53	383.47	-3.06
2/27/04	387.58		
2/28/04	386.08		
2/29/04	385.25		
3/1/04	384.94	na	
3/2/04	384.52	na	
3/3/04	385.40	na	
3/4/04	387.01	na	
3/5/04	392.50	384.47	-8.03
3/6/04	399.64	na	
3/7/04	404.19	na	
3/8/04	405.64	388.27	-17.37
3/9/04	404.52	na	
3/10/04	402.88	na	
3/11/04	400.82	na	
3/12/04	398.18	na	
3/13/04	396.89	na	
3/14/04	395.94	na	
3/15/04	394.33	390.77	-3.56
3/16/04	393.03	na	
3/17/04	392.88	na	
3/18/04	392.25	na	
3/19/04	391.88	na	
3/20/04	392.23	na	
3/21/04	392.12	na	
3/22/04	391.72	390.07	-1.65
3/23/04	390.31	390.07	-0.24
3/24/04	390.02	389.87	-0.15
3/25/04	389.36	389.57	0.21
3/26/04	389.83	na	
3/27/04	393.88	na	
3/28/04	397.92	na	
3/29/04	398.55	391.27	-7.28
3/30/04	397.91	391.67	-6.24
3/31/04	398.58	391.97	-6.61
4/1/04	399.34	392.27	-7.07
4/2/04	399.63	392.57	-7.06
4/3/04	399.34	na	
4/4/04	398.58	na	
4/5/04	398.02	392.97	-5.05

ATTACHMENT 4
OBSERVED HYDRAULIC GRADIENT ACROSS SITE R
Interim Operating Period Tech Memo

Date	River Stage Average Level	B-21B	B-21B Minus River ("Gradient Across Site R"
4/6/04	397.47	na	
4/7/04	397.16	393.06	-4.10
4/8/04	397.24	393.02	-4.22
4/9/04	396.76	393.02	-3.74
4/10/04	396.24	392.96	-3.28
4/11/04	395.60	392.90	-2.70
4/12/04	394.44	392.69	-1.76
4/13/04	393.24	392.42	-0.82
4/14/04	392.01	392.09	0.09
4/15/04	390.63	391.81	1.19
4/16/04	387.99	391.31	3.32
4/17/04	387.56	390.86	3.30
4/18/04	386.93	390.57	3.65
4/19/04	386.84	390.28	3.45
4/20/04	385.73	390.13	4.40
4/21/04	386.58	389.85	3.27
4/22/04	386.65	389.70	3.05
4/23/04	387.12	389.60	2.48
4/24/04	387.24	389.62	2.38
4/25/04	388.33	389.58	1.25
4/26/04	389.06	389.70	0.64
4/27/04	389.81	389.88	0.07
4/28/04	389.86	389.97	0.11
4/29/04	391.94	390.20	-1.74
4/30/04	392.33	390.51	-1.81
5/1/04	392.53	390.65	-1.89
5/2/04	393.50	390.88	-2.62
5/3/04	393.58	391.09	-2.49
5/4/04	393.51	391.26	-2.25
5/5/04	392.89	391.31	-1.58
5/6/04	392.03	391.22	-0.82
5/7/04	390.62	391.09	0.47
5/8/04	389.70	390.84	1.14
5/9/04	388.59	390.59	2.00
5/10/04	387.48	390.26	2.79
5/11/04	386.55	389.99	3.45
5/12/04	384.31	389.66	5.35
5/13/04	386.53	389.49	2.96
5/14/04	389.06	389.65	0.59
5/15/04	389.69	389.85	0.16
5/16/04	389.23	389.93	0.70
5/17/04	388.97	389.89	0.92
5/18/04	389.01	389.87	0.86
5/19/04	389.93	390.06	0.14
5/20/04	393.13	390.46	-2.67
5/21/04	395.04	391.03	-4.01
5/22/04	396.69	391.56	-5.13
5/23/04	398.16	392.14	-6.02
5/24/04	396.96	392.39	-4.57
5/25/04	396.45	392.51	-3.95
5/26/04	399.10	393.02	-6.08
5/27/04	403.26	394.03	-9.23
5/28/04	407.59	395.40	-12.19
5/29/04	408.09	396.49	-11.60
5/30/04	407.08	397.02	-10.05

ATTACHMENT 4
OBSERVED HYDRAULIC GRADIENT ACROSS SITE R
Interim Operating Period Tech Memo

Date	River Stage Average Level	B-21B	B-21B Minus River ("Gradient Across Site R"
5/31/04	405.79	397.11	-8.68
6/1/04	404.73	397.23	-7.50
6/2/04	404.59	397.34	-7.25
6/3/04	406.23	397.90	-8.33
6/4/04	407.21	398.54	-8.66
6/5/04	406.77	398.85	-7.91
6/6/04	406.15	398.96	-7.18
6/7/04	405.35	398.96	-6.39
6/8/04	404.55	398.89	-5.66
6/9/04	404.18	398.87	-5.31
6/10/04	403.99	398.98	-5.01
6/11/04	403.60	398.94	-4.65
6/12/04	403.04	398.81	-4.23
6/13/04	403.13	398.87	-4.26
6/14/04	403.25	398.97	-4.28
6/15/04	402.84	398.92	-3.91
6/16/04	403.15	398.98	-4.17
6/17/04	404.69	399.36	-5.33
6/18/04	405.95	399.84	-6.11
6/19/04	406.23	400.16	-6.07
6/20/04	405.88	400.35	-5.53
6/21/04	405.54	400.46	-5.08
6/22/04	405.08	400.27	-4.81
6/23/04	404.75	400.26	-4.49
6/24/04	404.64	400.28	-4.36
6/25/04	404.74	400.32	-4.43
6/26/04	404.44	400.31	-4.13
6/27/04	404.07	400.28	-3.79
6/28/04	403.60	400.16	-3.45
6/29/04	403.01	399.99	-3.03
6/30/04	402.31	399.82	-2.49
7/1/04	401.57	399.58	-1.99
7/2/04	400.85	399.35	-1.50
7/3/04	400.03	399.12	-0.91
7/4/04	398.90	398.64	-0.25
7/5/04	397.77	398.13	0.36
7/6/04	396.70	397.84	1.14
7/7/04	395.22	397.33	2.11
7/8/04	395.32	397.08	1.76
7/9/04	395.68	397.03	1.35
7/10/04	395.65	396.93	1.28
7/11/04	395.31	396.81	1.49
7/12/04	395.20	396.68	1.47
7/13/04	395.15	396.59	1.44
7/14/04	395.63	396.56	0.93
7/15/04	396.63	396.74	0.10
7/16/04	397.12	396.97	-0.15
7/17/04	396.42	396.83	0.40
7/18/04	394.97	396.44	1.47
7/19/04	394.08	396.11	2.03
7/20/04	394.16	395.96	1.80
7/21/04	393.98	395.85	1.87
7/22/04	393.27	395.59	2.32
7/23/04	392.49	395.24	2.74
7/24/04	391.98	394.94	2.97

ATTACHMENT 4
OBSERVED HYDRAULIC GRADIENT ACROSS SITE R
Interim Operating Period Tech Memo

Date	River Stage Average Level	B-21B	B-21B Minus River ("Gradient Across Site R"
7/25/04	391.54	394.74	3.20
7/26/04	390.83	394.52	3.68
7/27/04	390.33	394.28	3.95
7/28/04	390.09	394.03	3.94
7/29/04	390.34	393.98	3.64
7/30/04	390.36	393.94	3.58
7/31/04	389.86	393.70	3.84
8/1/04	389.95	393.61	3.65
8/2/04	388.24	393.36	5.11
8/3/04	386.91	392.98	6.07
8/4/04	387.05	392.73	5.67
8/5/04	388.19	392.66	4.47
8/6/04	389.70	392.78	3.08
8/7/04	391.20	393.11	1.91
8/8/04	389.77	392.99	3.22
8/9/04	388.23	392.69	4.45
8/10/04	387.88	392.48	4.60
8/11/04	386.54	392.23	5.69
8/12/04	385.62	391.89	6.27
8/13/04	385.38	391.68	6.29
8/14/04	385.14	391.37	6.22
8/15/04	385.67	391.06	5.40
8/16/04	385.13	390.73	5.60
8/17/04	384.80	390.56	5.76
8/18/04	384.67	390.34	5.67
8/19/04	385.13	390.08	4.95
8/20/04	386.05	389.89	3.83
8/21/04	385.45	389.78	4.33
8/22/04	385.05	389.73	4.67
8/23/04	385.88	389.57	3.70
8/24/04	386.70	389.39	2.69
8/25/04	385.53	389.16	3.63
8/26/04	388.07	389.40	1.33
8/27/04	390.88	389.96	-0.92
8/28/04	396.37	390.68	-5.68
8/29/04	399.88	391.72	-8.16
8/30/04	399.04	392.39	-6.65
8/31/04	399.10	392.82	-6.29
9/1/04	398.06	393.11	-4.95
9/2/04	394.78	392.96	-1.82
9/3/04	393.34	392.73	-0.61
9/4/04	391.66	392.47	0.82
9/5/04	389.13	392.12	3.00
9/6/04	387.10	391.63	4.53
9/7/04	385.99	391.23	5.24
9/8/04	385.20	390.91	5.70
9/9/04	384.85	390.54	5.68
9/10/04	384.43	390.29	5.86
9/11/04	384.60	390.07	5.47
9/12/04	384.23	389.79	5.57
9/13/04	385.13	389.58	4.45
9/14/04	384.84	389.38	4.54
9/15/04	384.81	389.18	4.37
9/16/04	384.69	388.93	4.24
9/17/04	384.61	388.50	3.89

ATTACHMENT 4
OBSERVED HYDRAULIC GRADIENT ACROSS SITE R
Interim Operating Period Tech Memo

Date	River Stage Average Level	B-21B	B-21B Minus River ("Gradient Across Site R"
9/18/04	384.53	388.15	3.63
9/19/04	384.82	387.93	3.10
9/20/04	385.44	387.77	2.33
9/21/04	384.71	387.56	2.85
9/22/04	384.49	387.53	3.04
9/23/04	385.91	388.54	2.63
9/24/04	387.39	388.96	1.57
9/25/04	387.82	388.25	0.42
9/26/04	387.55	388.00	0.45
9/27/04	386.74	387.89	1.15
9/28/04	386.40	387.74	1.35
9/29/04	385.57	387.66	2.09
9/30/04	384.90	387.53	2.63
10/1/04	384.43	387.66	3.23
10/2/04	384.20	387.23	3.03
10/3/04	383.15	387.24	4.10
10/4/04	383.96	387.28	3.33
10/5/04	384.37	387.01	2.63
10/6/04	384.87	386.73	1.86
10/7/04	383.61	386.58	2.97
10/8/04	383.40	386.40	3.00
10/9/04	383.52	386.24	2.72
10/10/04	383.69	386.11	2.42
10/11/04	383.55	386.09	2.54
10/12/04	383.94	386.45	2.51
10/13/04	385.25	386.62	1.37
10/14/04	384.79	386.75	1.96
10/15/04	384.12	386.76	2.64
10/16/04	383.64	386.65	3.01
10/17/04	383.36	386.64	3.28
10/18/04	382.63	386.62	4.00
10/19/04	381.91	386.46	4.55
10/20/04	381.29	386.39	5.10
10/21/04	381.23	386.26	5.03
10/22/04	381.61	386.19	4.59
10/23/04	382.60	386.12	3.52
10/24/04	383.43	386.01	2.59
10/25/04	382.39	385.99	3.60
10/26/04	383.27	386.00	2.73
10/27/04	383.63	386.06	2.43
10/28/04	384.42	386.25	1.83
10/29/04	381.28	386.52	5.24
10/30/04	384.65	386.57	1.92
10/31/04	383.39	386.58	3.19
11/1/04	383.92	386.61	2.70
11/2/04	391.03	386.71	-4.32
11/3/04	393.51	387.32	-6.20
11/4/04	393.96	387.75	-6.21
11/5/04	393.09	388.18	-4.91
11/6/04	393.15	388.62	-4.53
11/7/04	392.33	388.84	-3.49
11/8/04	391.39	389.08	-2.31
11/9/04	390.15	389.35	-0.80
11/10/04	389.62	389.51	-0.11
11/11/04	389.74	389.57	-0.17

ATTACHMENT 4
OBSERVED HYDRAULIC GRADIENT ACROSS SITE R
Interim Operating Period Tech Memo

Date	River Stage Average Level	B-21B	B-21B Minus River ("Gradient Across Site R"
11/12/04	390.51	389.66	-0.85
11/13/04	389.77	389.76	-0.01
11/14/04	388.52	389.74	1.22
11/15/04	388.05	389.53	1.48
11/16/04	387.01	389.35	2.34
11/17/04	386.20	388.96	2.76
11/18/04	385.76	388.69	2.93
11/19/04	385.61	388.56	2.95
11/20/04	385.75	388.32	2.56
11/21/04	385.94	388.22	2.28
11/22/04	385.57	388.22	2.65
11/23/04	384.50	388.06	3.57
11/24/04	384.80	387.71	2.90
11/25/04	387.73	387.75	0.03
11/26/04	391.66	388.50	-3.17
11/27/04	393.27	389.10	-4.17
11/28/04	396.07	389.51	-6.56
11/29/04	396.52	390.08	-6.43
11/30/04	395.10	390.74	-4.35
12/1/04	395.31	391.06	-4.25
12/2/04	394.82	391.37	-3.45
12/3/2004	393.88	391.39	-2.49
12/4/2004	392.94	391.39	-1.55
12/5/2004	391.53	391.36	-0.16
12/6/2004	391.11	391.05	-0.06
12/7/2004	394.30	391.03	-3.27
12/8/2004	397.99	391.68	-6.31
12/9/2004	397.82	392.39	-5.43
12/10/2004	396.99	392.64	-4.35
12/11/2004	395.35	392.81	-2.54
12/12/2004	393.80	392.87	-0.93
12/13/2004	393.04	392.34	-0.70
12/14/2004	392.34	392.18	-0.16
12/15/2004	391.81	392.13	0.32
12/16/2004	391.41	391.65	0.24
12/17/2004	390.88	391.67	0.79
12/18/2004	389.88	391.35	1.47
12/19/2004	389.92	390.88	0.96
12/20/2004	388.88	390.80	1.92
12/21/2004	388.37	390.28	1.91
12/22/2004	387.32	389.97	2.65
12/23/2004	385.08	389.50	4.42
12/24/2004	383.40	389.14	5.74
12/25/2004	383.65	388.84	5.19
12/26/2004	384.12	388.44	4.32
12/27/2004	383.99	388.25	4.26
12/28/2004	384.06	388.16	4.10
12/29/2004	383.70	387.91	4.21
12/30/2004	383.53	387.80	4.27
12/31/2004	382.70	387.52	4.82
1/1/2005	383.08	387.35	4.27
1/2/2005	382.25	387.17	4.92
1/3/2005	385.14	387.48	2.34
1/4/2005	391.60	388.47	-3.13
1/5/2005	401.15	389.37	-11.78
1/6/2005	408.18	390.61	-17.57
1/7/2005	408.37	391.75	-16.62
1/8/2005	404.28	392.60	-11.68
1/9/2005	401.78	393.32	-8.46
1/10/2005	399.53	393.67	-5.86
1/11/2005	397.77	393.93	-3.84
1/12/2005	396.81	394.06	-2.75
1/13/2005	400.00	393.92	-6.08

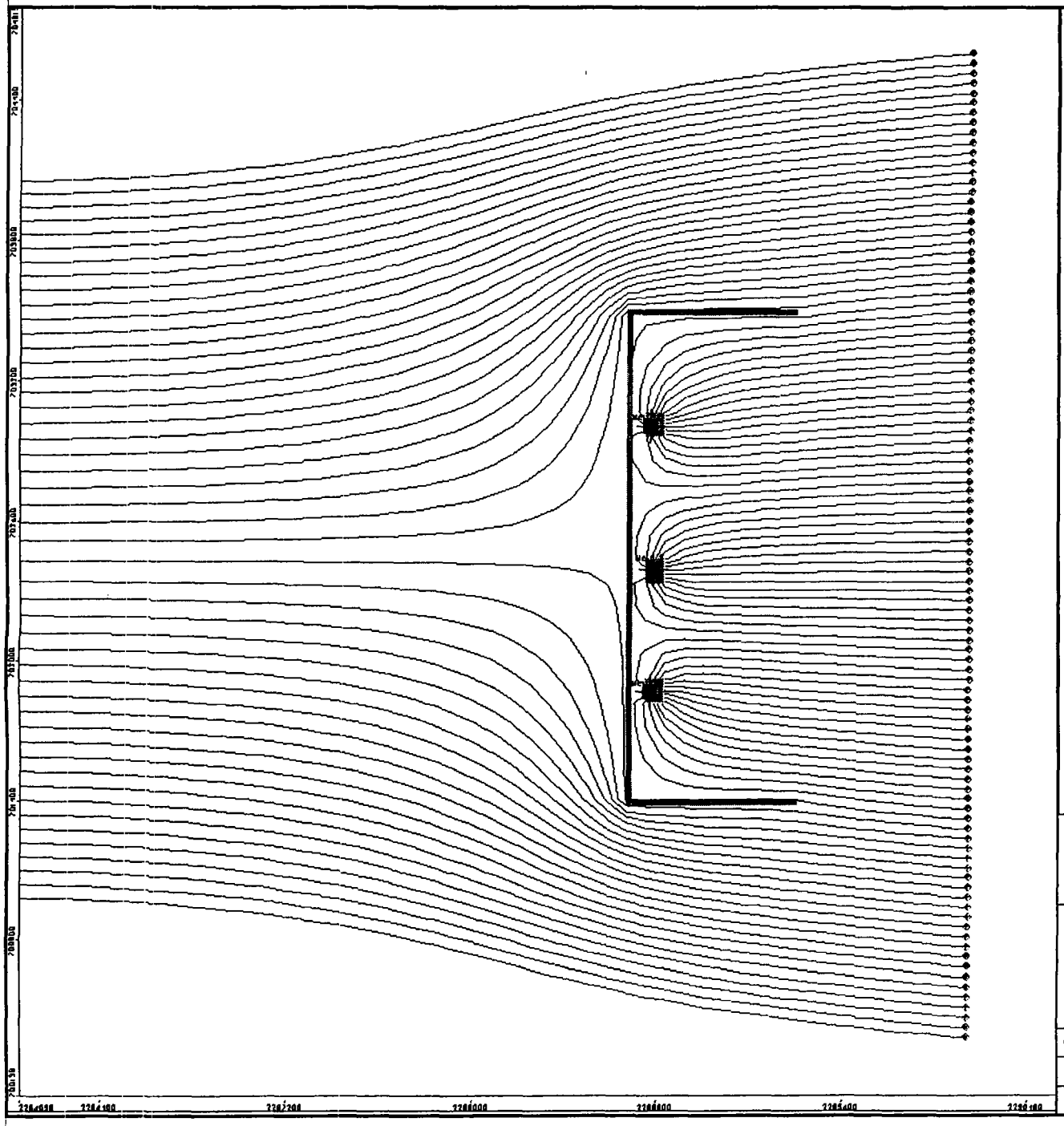
ATTACHMENT 4
OBSERVED HYDRAULIC GRADIENT ACROSS SITE R
Interim Operating Period Tech Memo

Date	River Stage Average Level	B-21B	B-21B Minus River ("Gradient Across Site R"
1/14/2005	405.15	394.93	-10.22
1/15/2005	405.04	395.79	-9.25
1/16/2005	401.78	396.07	-5.70
1/17/2005	400.17	396.26	-3.91
1/18/2005	NA	396.41	
1/19/2005	NA	396.13	
1/20/2005	395.76	395.91	0.15
1/21/2005	395.49	395.64	0.15
1/22/2005	395.31	395.43	0.12
1/23/2005	392.86	395.28	2.42
1/24/2005	393.76	395.30	1.54
1/25/2005	393.77	395.23	1.46
1/26/2005	393.26	394.86	1.60
1/27/2005	392.58	394.58	2.00
1/28/2005	391.90	394.46	2.56
1/29/2005	391.81	394.37	2.56
1/30/2005	391.65	394.24	2.59
1/31/2005	391.36	394.06	2.70

Maximum Gradient Across Site R	6.29	ft

ATTACHMENT 5

Observed Gradients across Sauget Area 2 Site R



N

LEGEND

- Pumping Well
- Particle Flow Line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 1 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

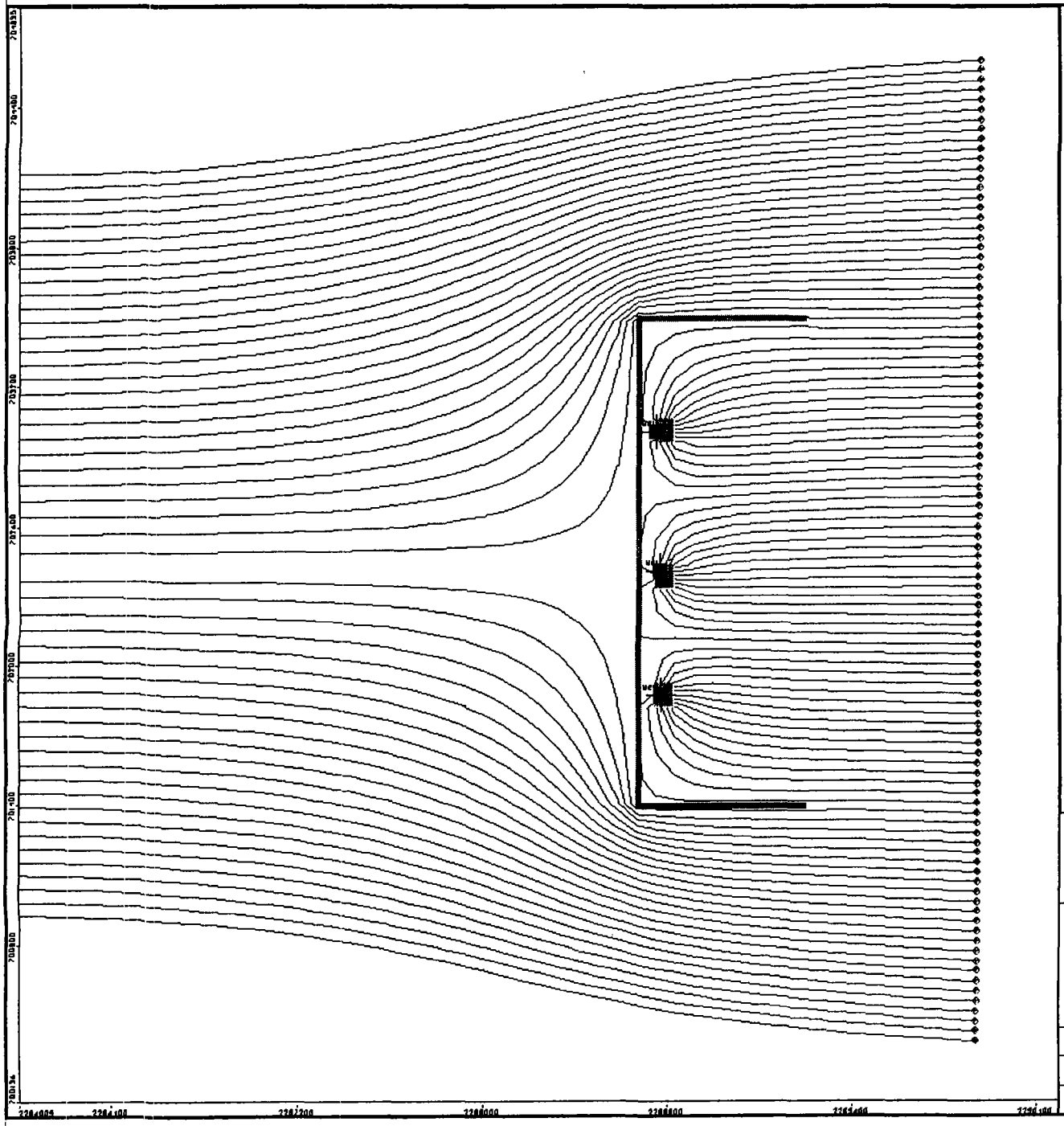
0 500

GROUNDWATER SERVICES, INC.

CASE 1: 1 FT GRADIENT
$Q_{IN} < Q_{OUT}$
(TOTAL Q = 295 GPM)

Sauget and Cahokia, Illinois

GSI Job No.: G-2898	Drawn by: SKF	**Figure 5.1**
Issued: 04/1/05	Approved by: CJN	
Scale: As Shown	Revised: --	



N

LEGEND

- Pumping Well
- Particle Flow Line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 1 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

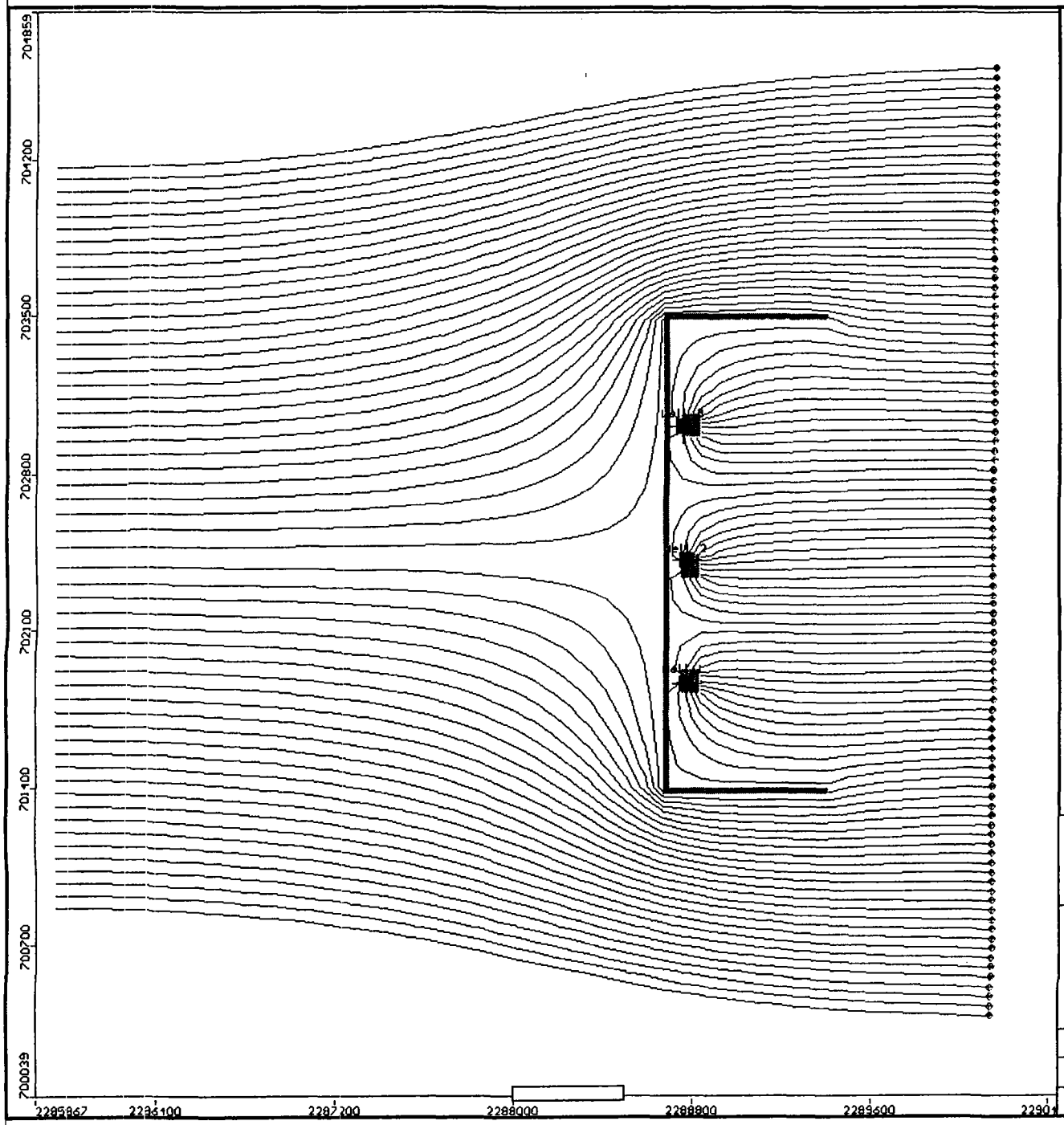
0 500

GROUNDWATER SERVICES, INC.

CASE 2: 1 FT GRADIENT
$Q_{IN} = Q_{OUT}$
(TOTAL Q = 265 GPM)

Sauget and Cahokia, Illinois

GSI Job No.: G-2898	Drawn by: SKF	**Figure 5.2**
Issued: 04/1/05	Approved by: CJN	
Scale: As Shown	Revised: --	



N

LEGEND

- Pumping Well
- Particle Flow Line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 1 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

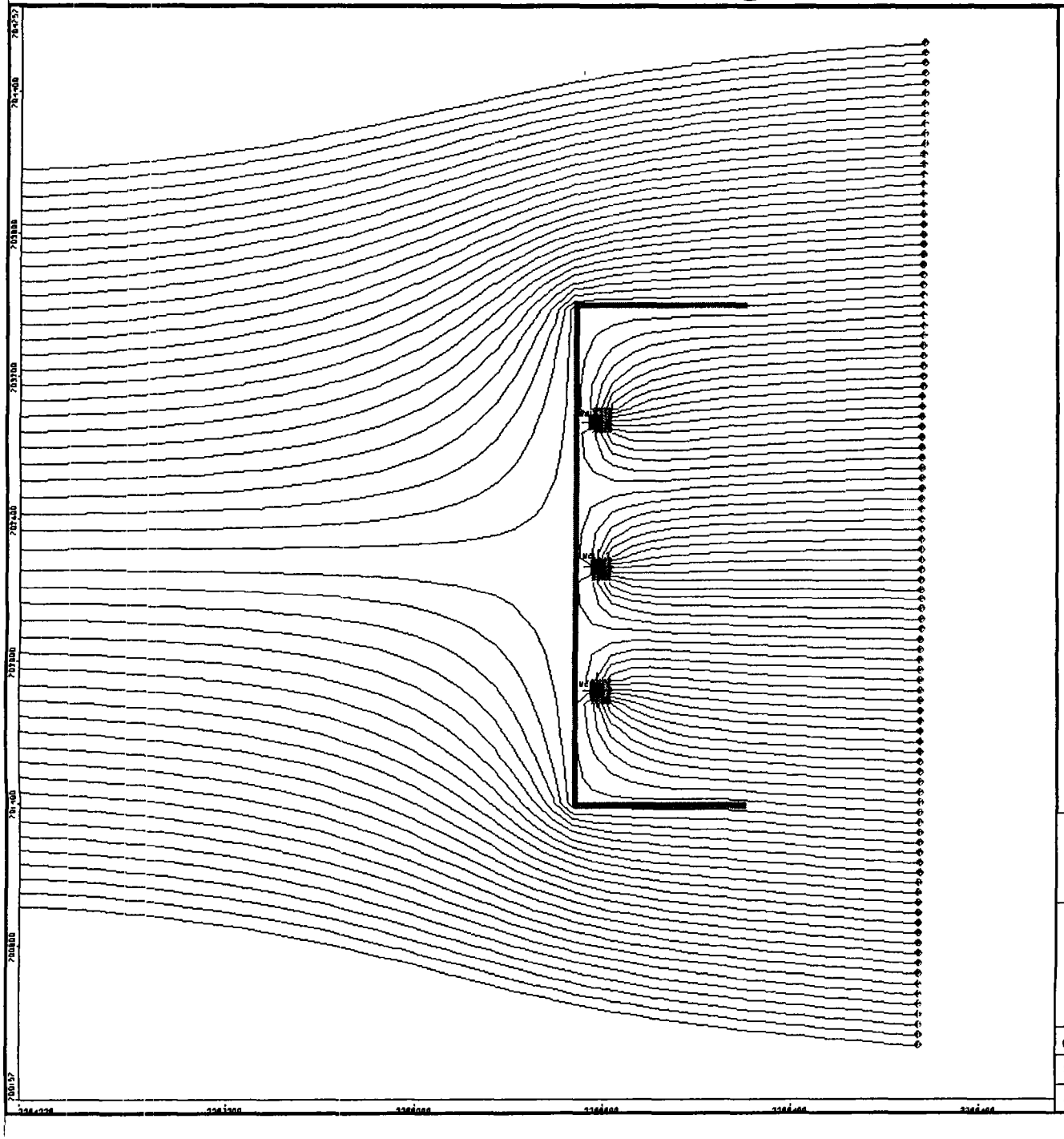
0 500

GROUNDWATER SERVICES, INC.

CASE 3: 1 FT GRADIENT
$Q_{IN} > Q_{OUT}$
(TOTAL Q = 235 GPM)

Sauget and Cahokia, Illinois

GSI Job No.:	G-2898	Drawn by:	SKF	Figure 5.3
Issued:	04/1/05	Approved by:	CJN	
Scale:	As Shown	Revised:	--	



N

LEGEND

- Pumping Well
- Particle Flow Line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 2 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

0 500

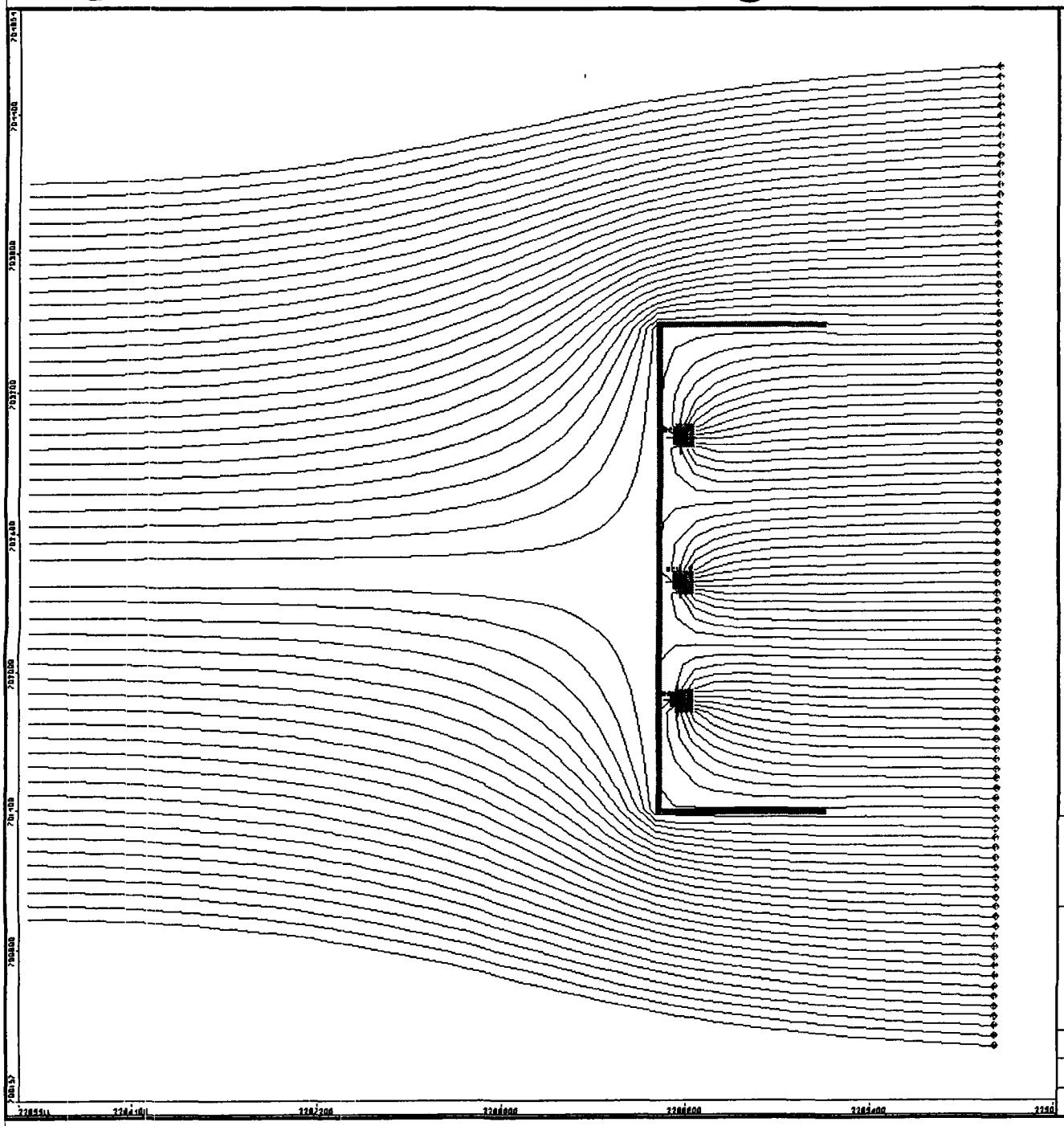
GROUNDWATER SERVICES, INC.

CASE 1: 2 FT GRADIENT
$Q_{IN} < Q_{OUT}$
(TOTAL Q = 588 GPM)

Sauget and Cahokia, Illinois

GSI Job No.:	G-2898	Drawn by:	SKF
Issued:	04/1/05	Approved by:	CJN
Scale:	As Shown	Revised:	--

Figure 5.4



N

LEGEND

- Pumping Well
- Particle Flow Line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 2 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

0 500

GROUNDWATER SERVICES, INC.

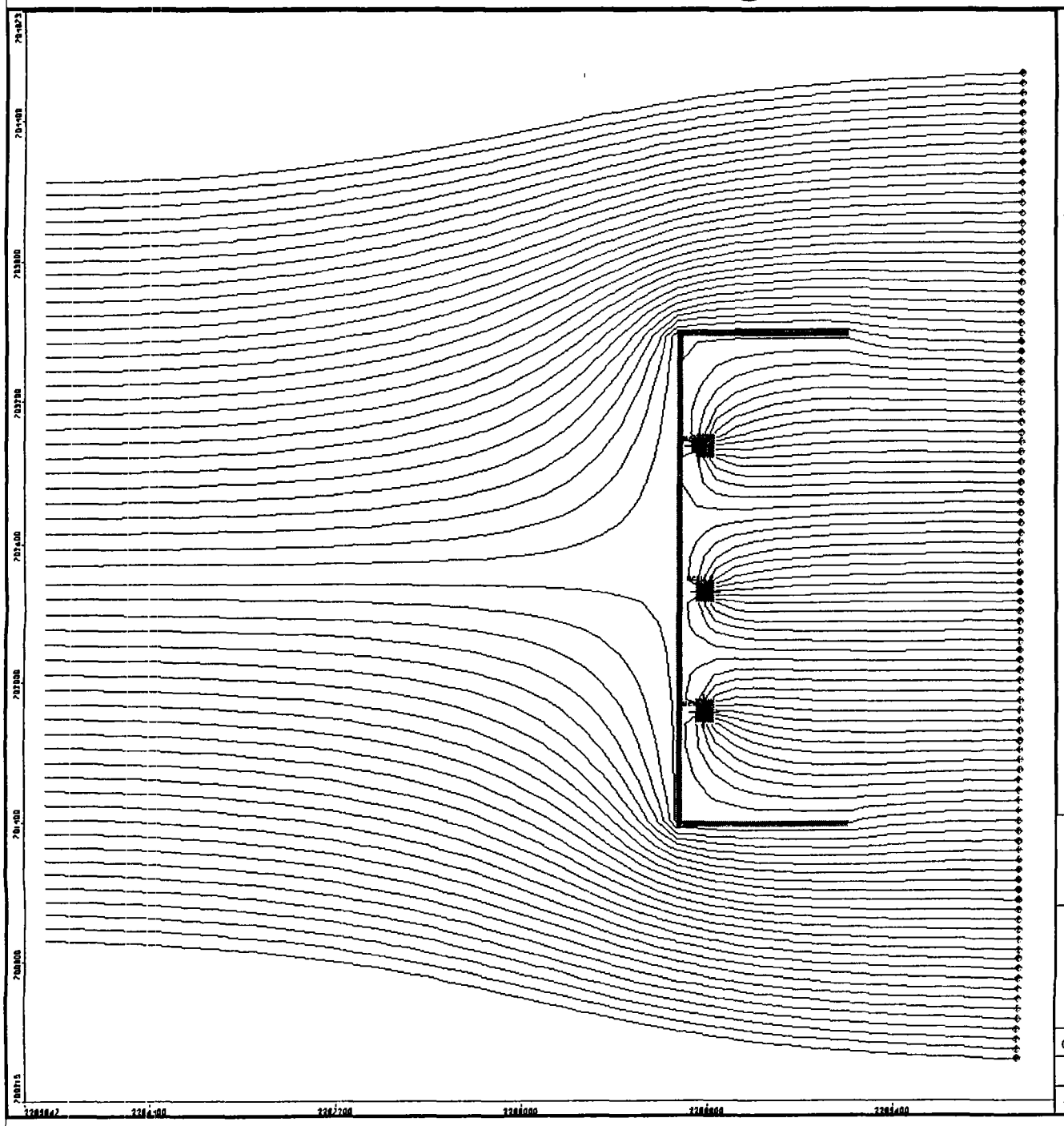
CASE 2: 2 FT GRADIENT

$Q_{IN} = Q_{OUT}$

(TOTAL Q = 543 GPM)

Sauget and Cahokia, Illinois

GSI Job No.: G-2898	Drawn by: SKF	**Figure 5.5**
Issued: 04/1/05	Approved by: CJN	
Scale: As Shown	Revised: --	



N

LEGEND

- Pumping Well
- Particle Flow Line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 2 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

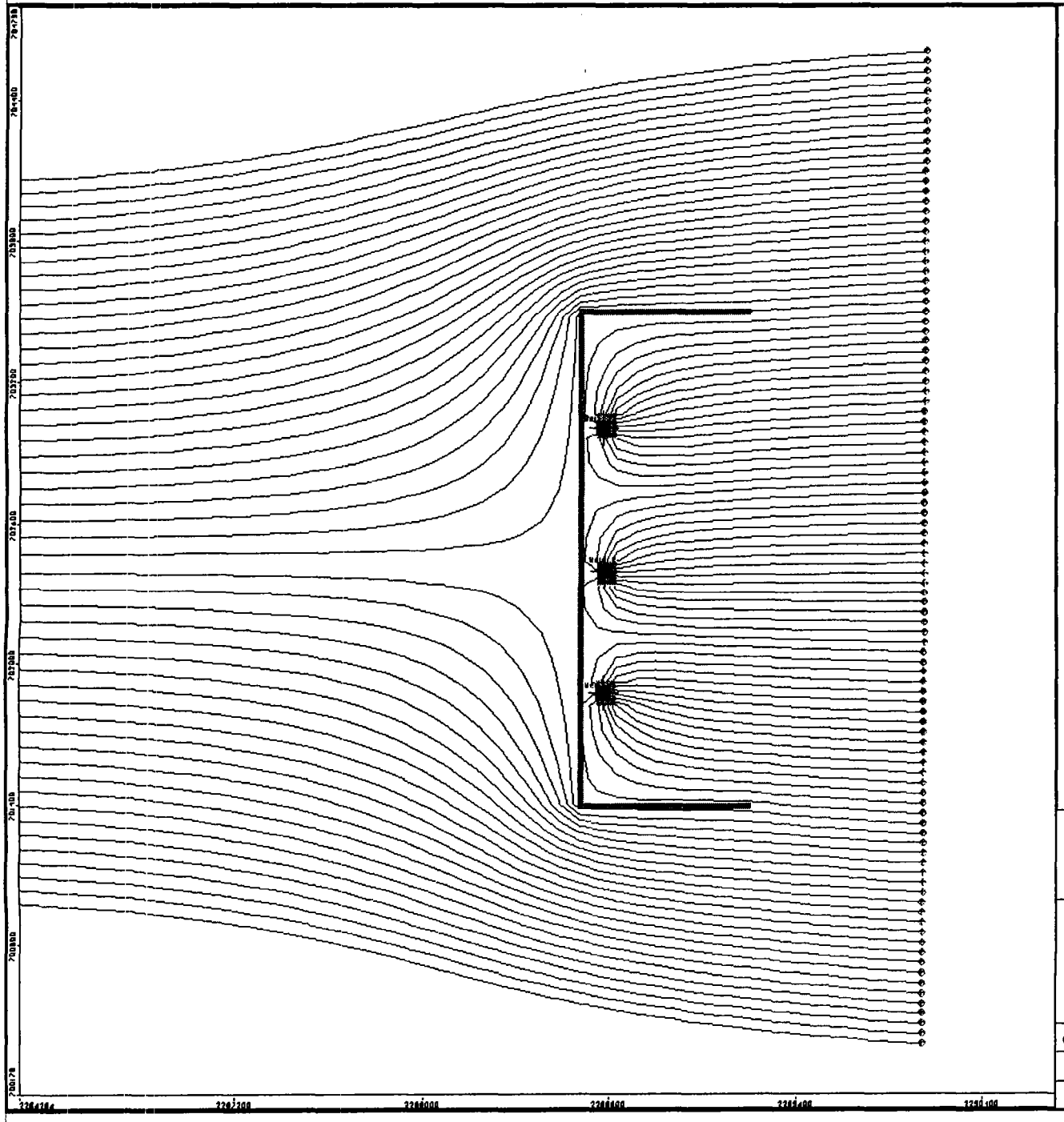
0 500

GROUNDWATER SERVICES, INC.

CASE 3: 2 FT GRADIENT
$Q_{IN} > Q_{OUT}$
(TOTAL Q = 498 GPM)

Sauget and Cahokia, Illinois

GSI Job No.:	G-2898	Drawn by:	SKF	**Figure 5.6**
Issued:	04/1/05	Approved by:	CJN	
Scale:	As Shown	Revised:	--	



N

LEGEND

- Pumping Well
- Particle Flow Line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 3 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

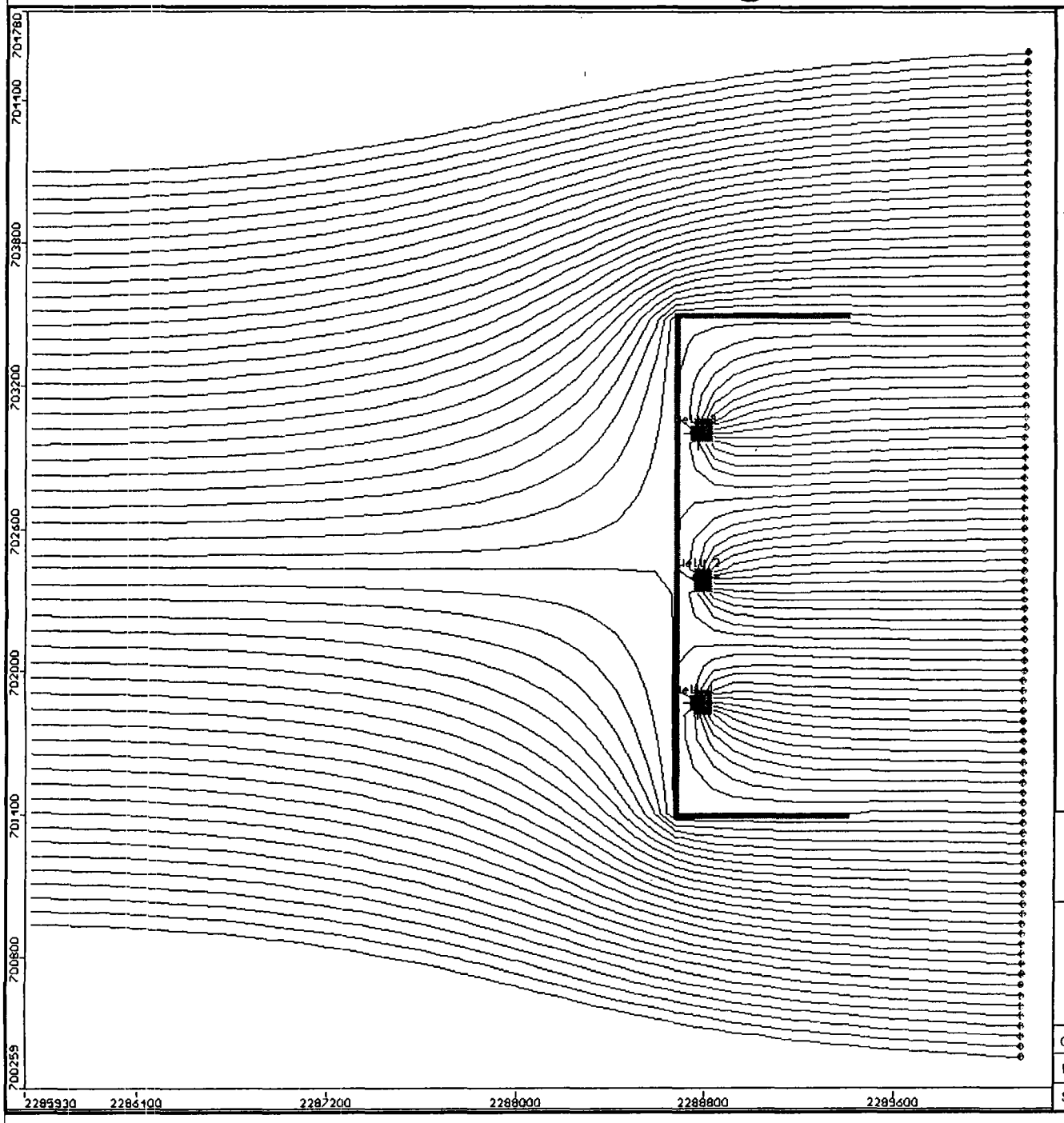
0 500

GROUNDWATER SERVICES, INC.

CASE 1: 3 FT GRADIENT
$Q_{IN} < Q_{OUT}$
(TOTAL Q = 1086 GPM)

Sauget and Cahokia, Illinois

GSI Job No.: G-2898	Drawn by: SKF	**Figure 5.7**
Issued: 04/1/05	Approved by: CJN	
Scale: As Shown	Revised: --	



N

LEGEND

- Pumping Well
- Particle Flow Line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 3 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

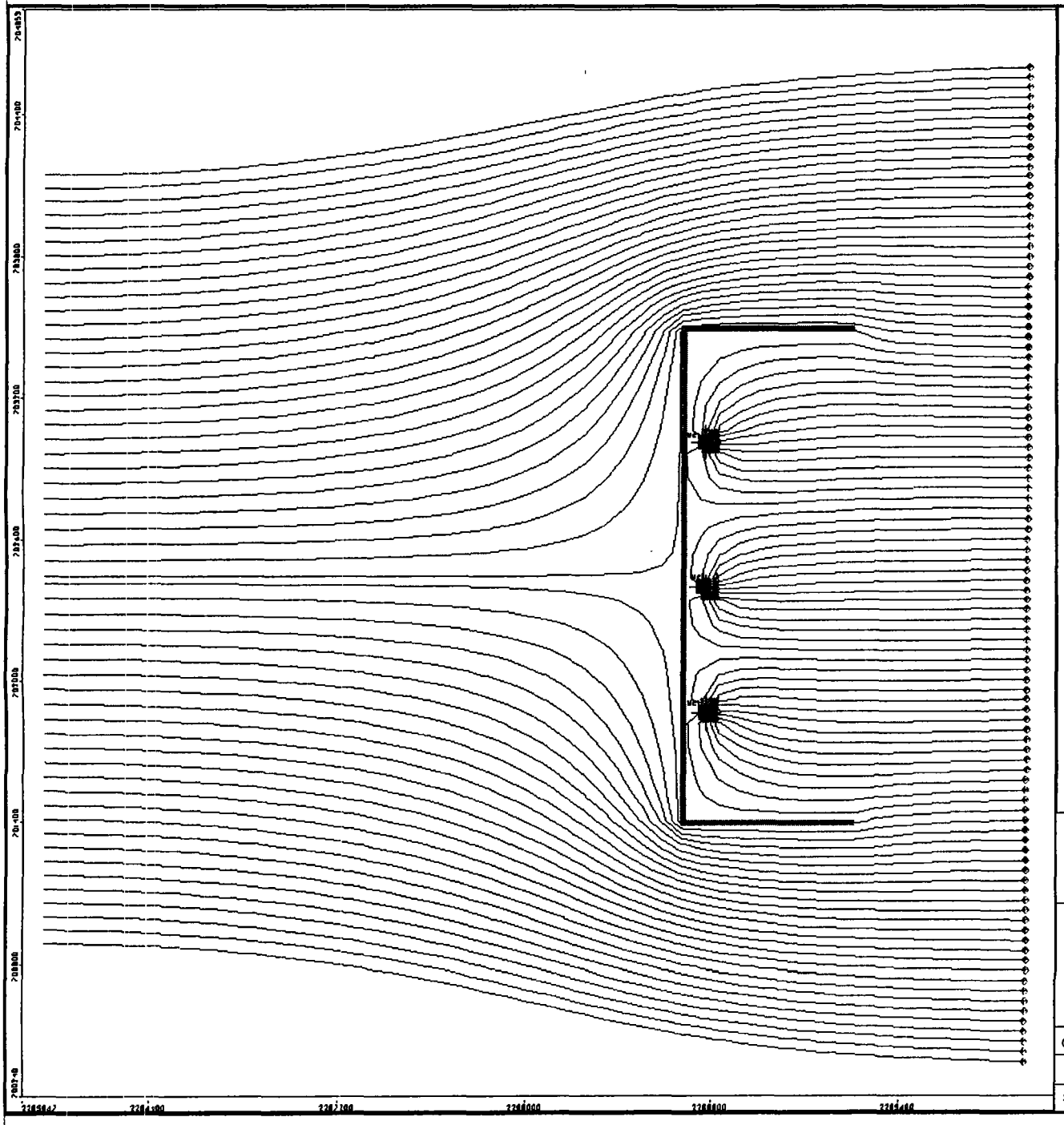
0 500

GROUNDWATER SERVICES, INC.

CASE 2: 3 FT GRADIENT
$Q_{IN} = Q_{OUT}$
(TOTAL Q = 996 GPM)

Sauget and Cahokia, Illinois

GSI Job No.:	G-2898	Drawn by:	SKF	**Figure 5.8**
Issued:	04/1/05	Approved by:	CJN	
Scale:	As Shown	Revised:	--	



N

LEGEND

- Pumping Well
- Particle Flow Line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 3 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

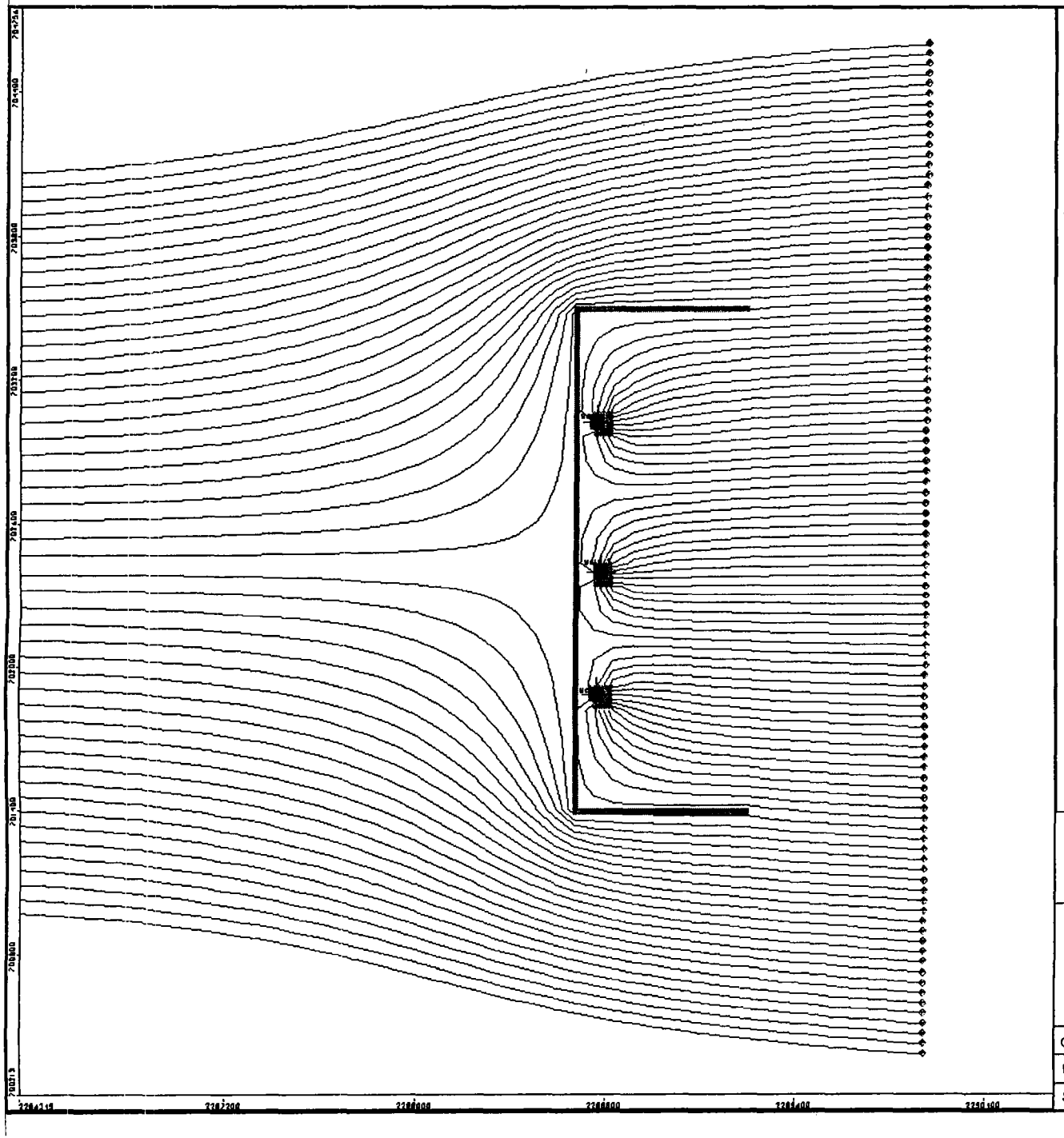
0 500

GROUNDWATER SERVICES, INC.

CASE 3: 3 FT GRADIENT
$Q_{IN} > Q_{OUT}$
(TOTAL Q = 906 GPM)

Sauget and Cahokia, Illinois

GSI Job No.: G-2898	Drawn by: SKF	**Figure 5.9**
Issued: 04/1/05	Approved by: CJN	
Scale: As Shown	Revised: --	



N

LEGEND

- Pumping Well
- Particle Flow Line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 4 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

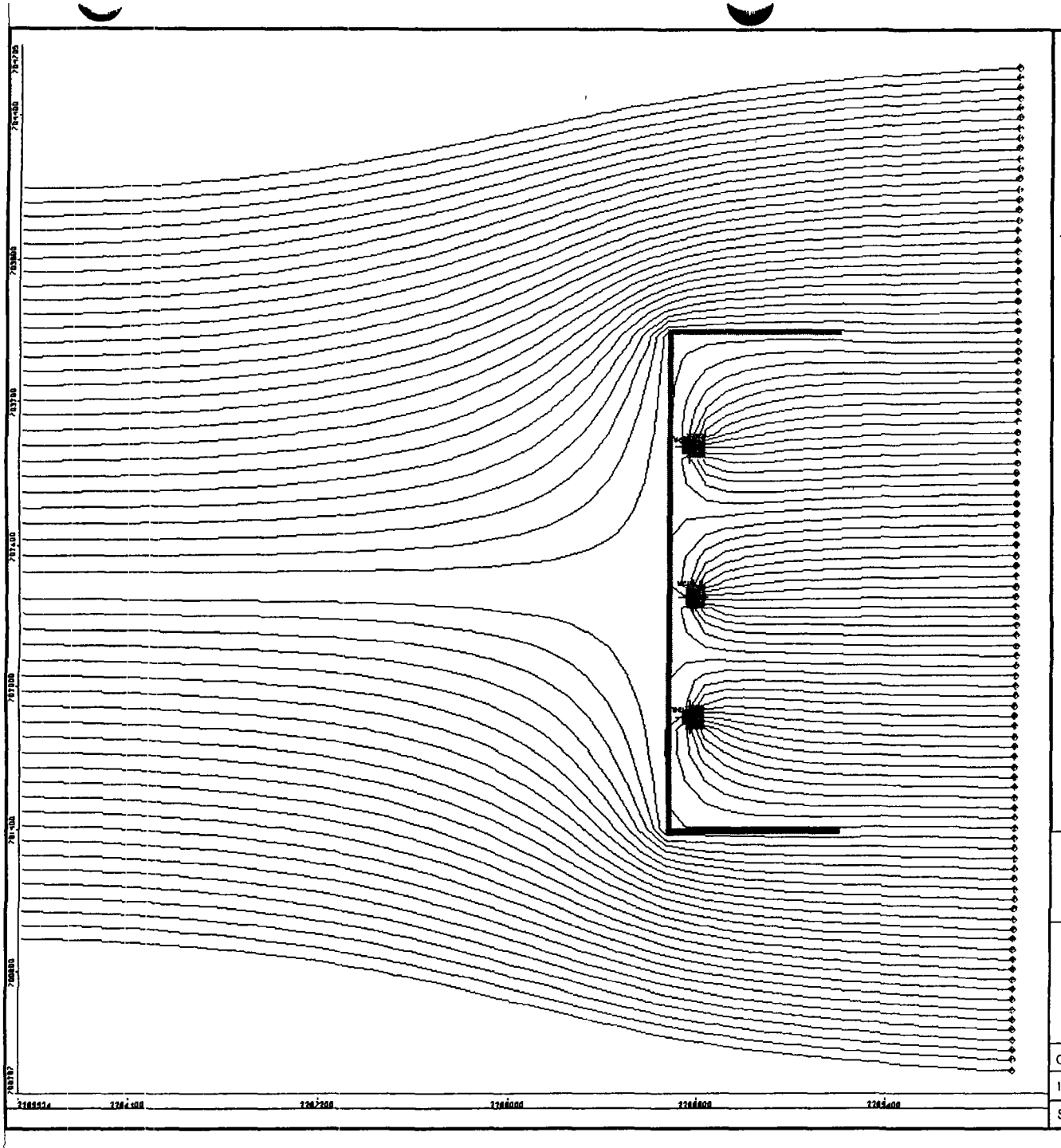
0 500

GROUNDWATER SERVICES, INC.

CASE 1: 4 FT GRADIENT
$Q_{IN} < Q_{OUT}$
(TOTAL Q = 1209 GPM)

Sauget and Cahokia, Illinois

GSI Job No.: G-2898	Drawn by: SKF	**Figure 5.10**
Issued: 04/1/05	Approved by: CJN	
Scale: As Shown	Revised: --	



N

LEGEND

- Pumping Well
- Particle Flow Line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 4 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

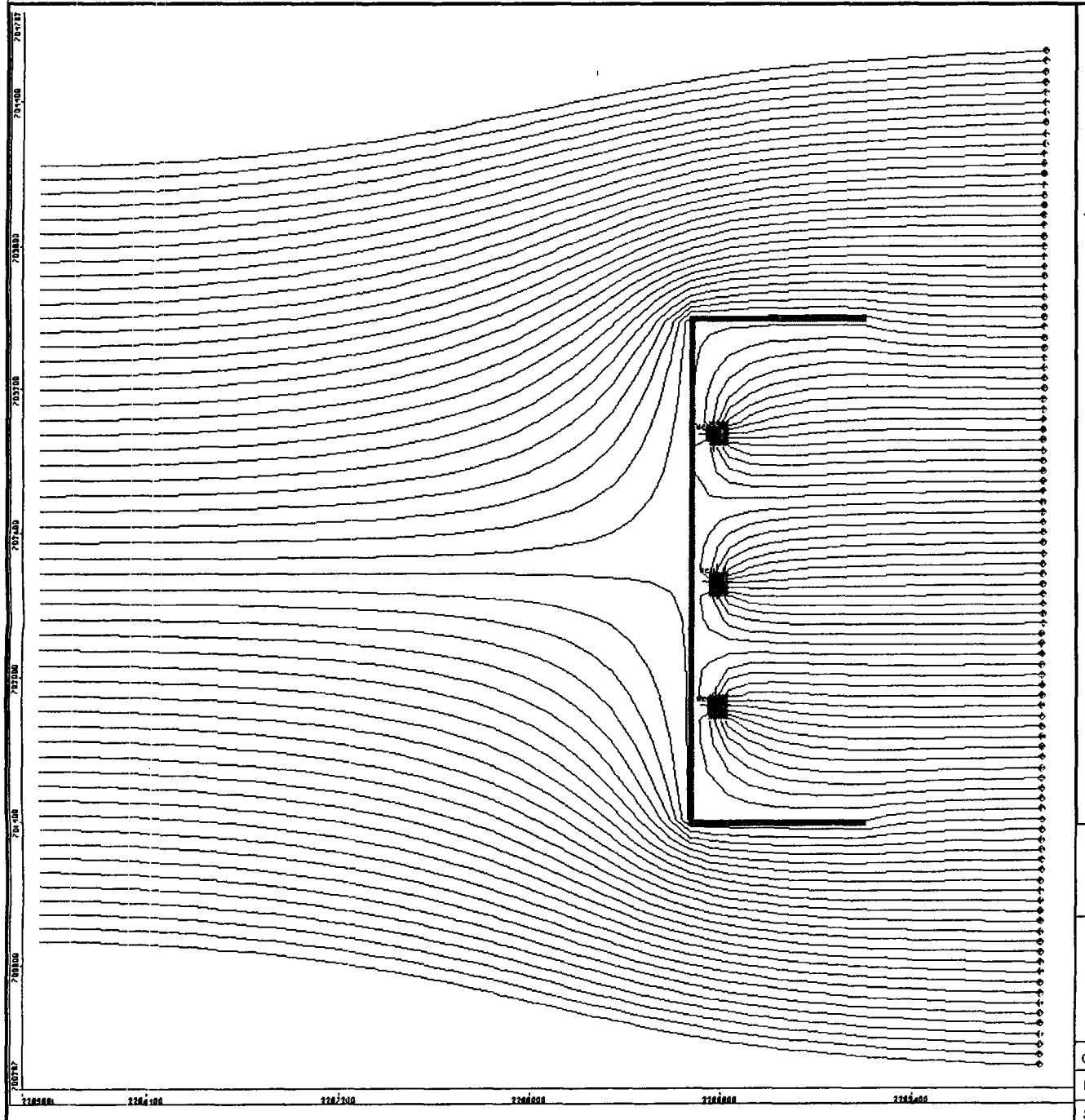
0 500

GROUNDWATER SERVICES, INC.

CASE 2: 4 FT GRADIENT
$Q_{IN} = Q_{OUT}$
(TOTAL Q = 1119 GPM)

Sauget and Cahokia, Illinois

GSI Job No.:	G-2898	Drawn by:	SKF	**Figure 5.11**
Issued:	04/1/05	Approved by:	CJN	
Scale:	As Shown	Revised:	--	



N

LEGEND

- Pumping Well
- Particle Flow Line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 4 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

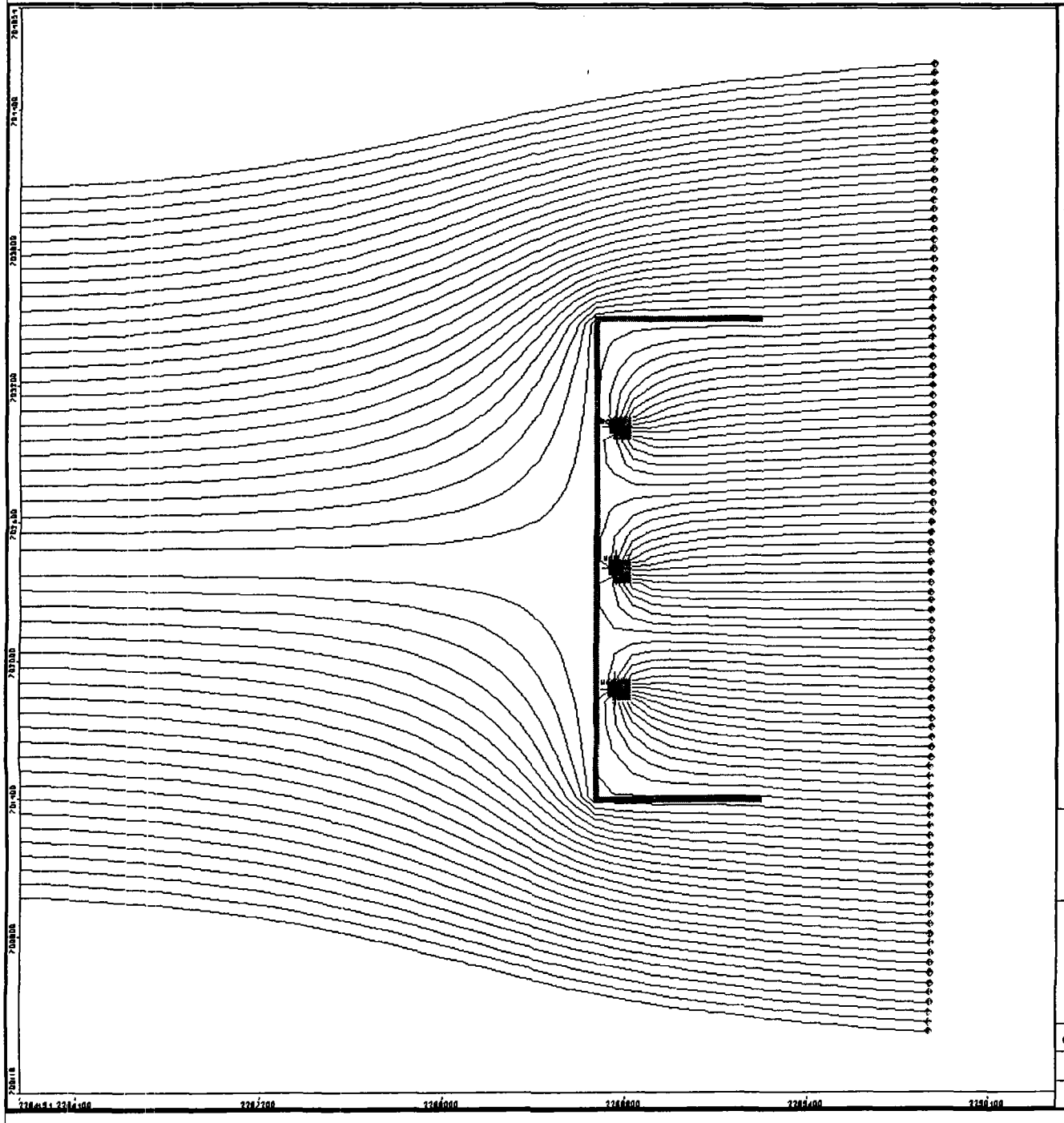
0 500

GROUNDWATER SERVICES, INC.

CASE 3: 4 FT GRADIENT
$Q_{IN} > Q_{OUT}$
(TOTAL Q = 1029 GPM)

Sauget and Cahokia, Illinois

GSI Job No.: G-2898	Drawn by: SKF	**Figure 5.12**
Issued: 04/1/05	Approved by: CJN	
Scale: As Shown	Revised: --	



N

LEGEND

- Pumping Well
- Particle Flow Line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 5 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

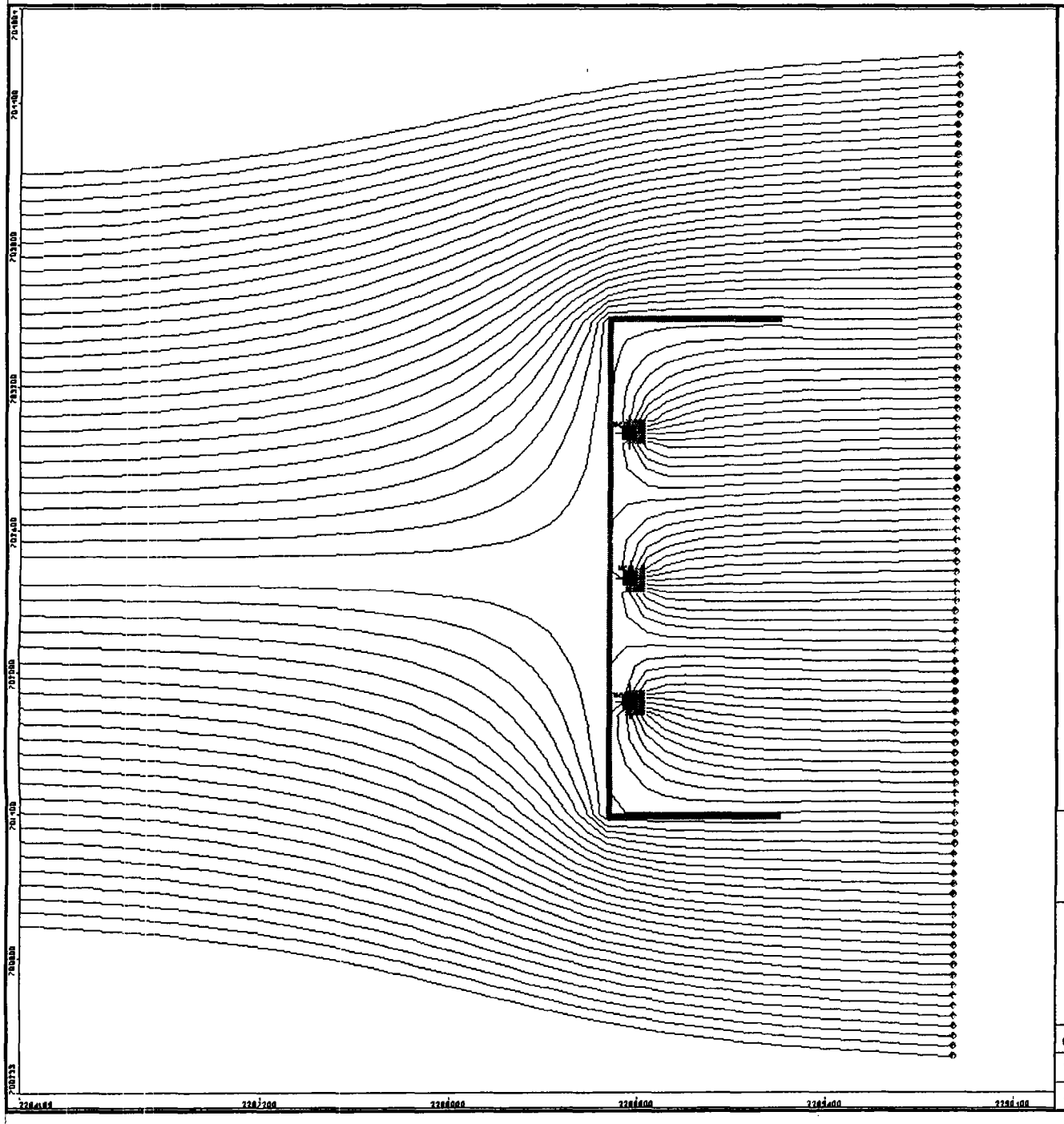
0 500

GROUNDWATER SERVICES, INC.

CASE 1: 5 FT GRADIENT
$Q_{IN} < Q_{OUT}$
(TOTAL Q = 1483 GPM)

Sauget and Cahokia, Illinois

GSI Job No.:	G-2898	Drawn by:	SKF	**Figure 5.13**
Issued:	04/1/05	Approved by:	CJN	
Scale:	As Shown	Revised:	--	



N

LEGEND

- Pumping Well
- Particle Flow Line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 5 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

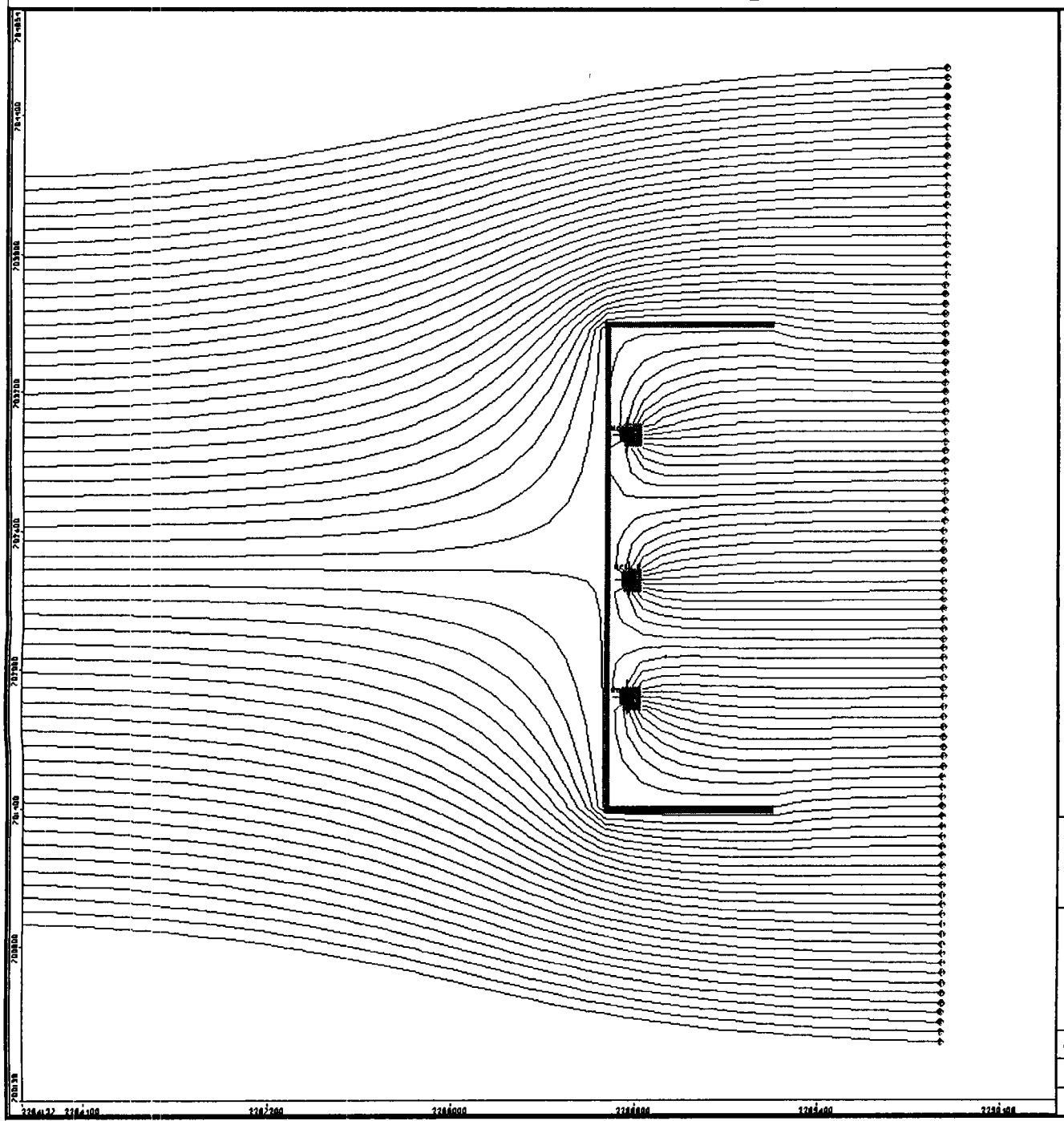
0 500

GROUNDWATER SERVICES, INC.

CASE 2: 5 FT GRADIENT
$Q_{IN} = Q_{OUT}$
(TOTAL Q = 1383 GPM)

Sauget and Cahokia, Illinois

GSI Job No.:	G-2898	Drawn by:	SKF	**Figure 5.14**
Issued:	04/1/05	Approved by:	CJN	
Scale:	As Shown	Revised:	--	



N

LEGEND

- Pumping Well
- Particle Flow Line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 5 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

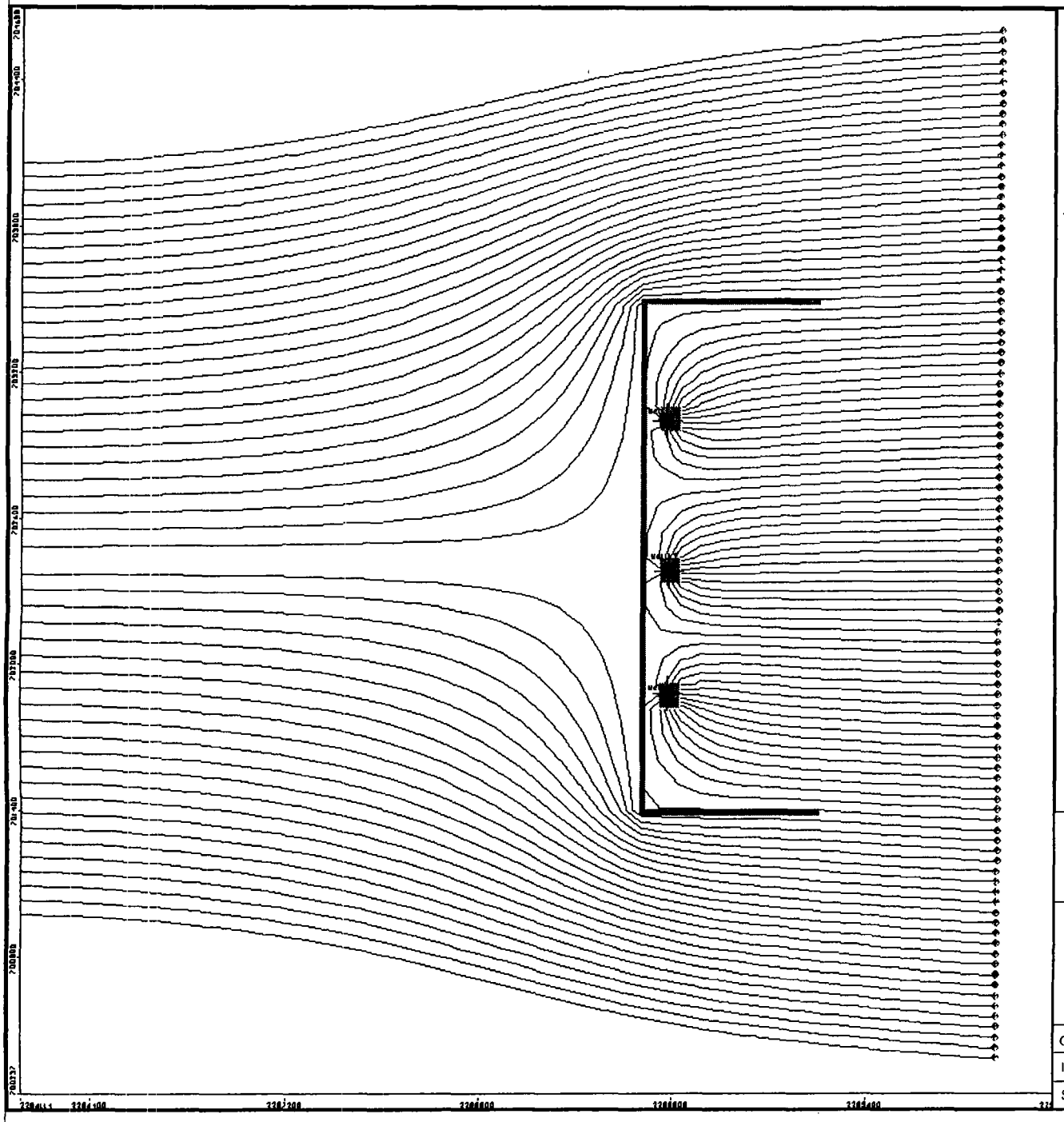
0 500

GROUNDWATER SERVICES, INC.

CASE 3: 5 FT GRADIENT
$Q_{IN} > Q_{OUT}$
(TOTAL Q = 1283 GPM)

Sauget and Cahokia, Illinois

GSI Job No.:	G-2898	Drawn by:	SKF	**Figure 5.15**
Issued:	04/1/05	Approved by:	CJN	
Scale:	As Shown	Revised:	--	



N

LEGEND

- Pumping Well
- Particle Flow Line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 6 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

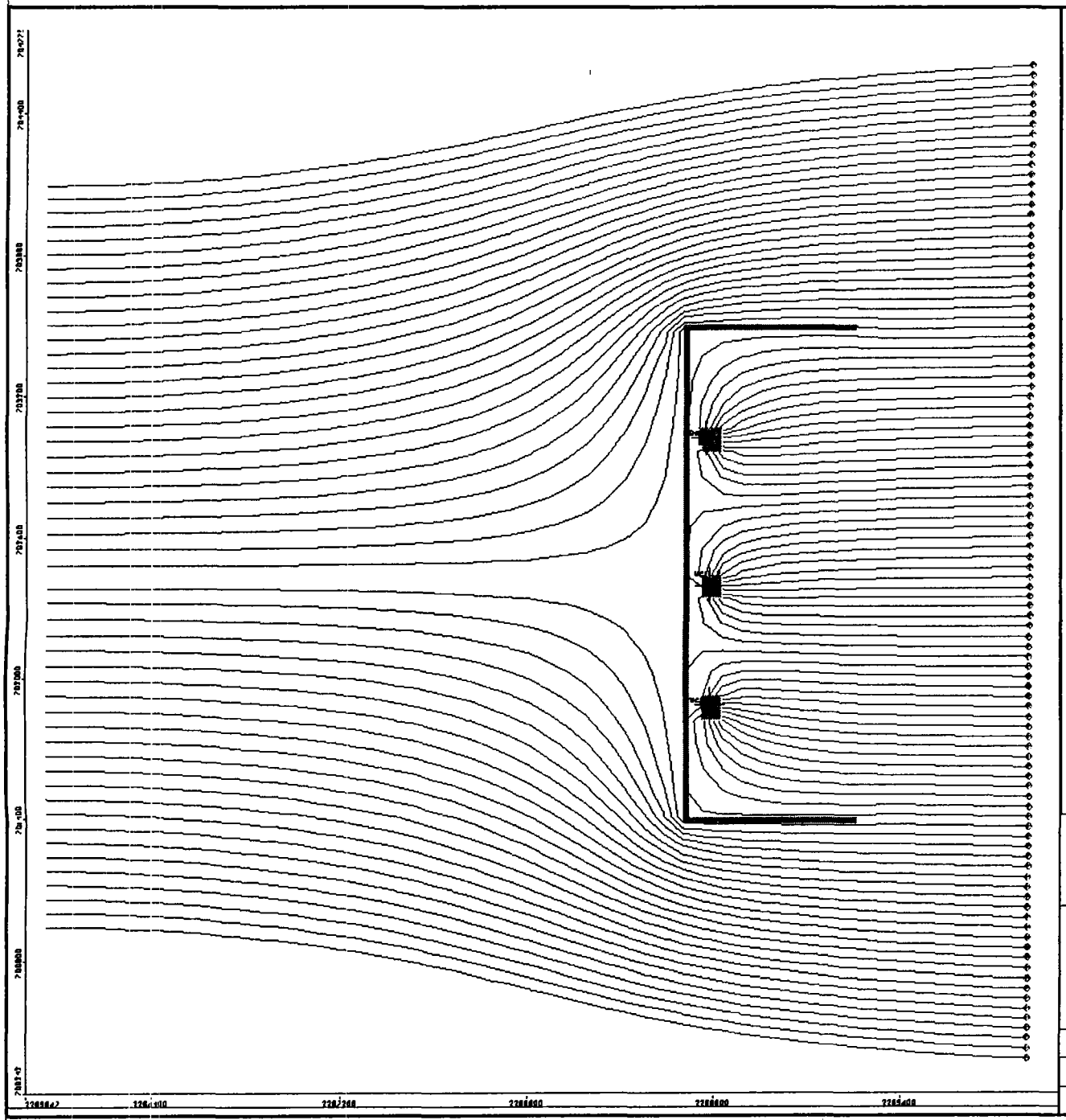
0 500

GROUNDWATER SERVICES, INC.

CASE 1: 6 FT GRADIENT
$Q_{IN} < Q_{OUT}$
(TOTAL Q = 1735 GPM)

Sauget and Cahokia, Illinois

GSI Job No.:	G-2898	Drawn by:	SKF	**Figure 5.16**
Issued:	04/1/05	Approved by:	CJN	
Scale:	As Shown	Revised:	--	



N

LEGEND

- Pumping Well
- Particle Flow Line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 6 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

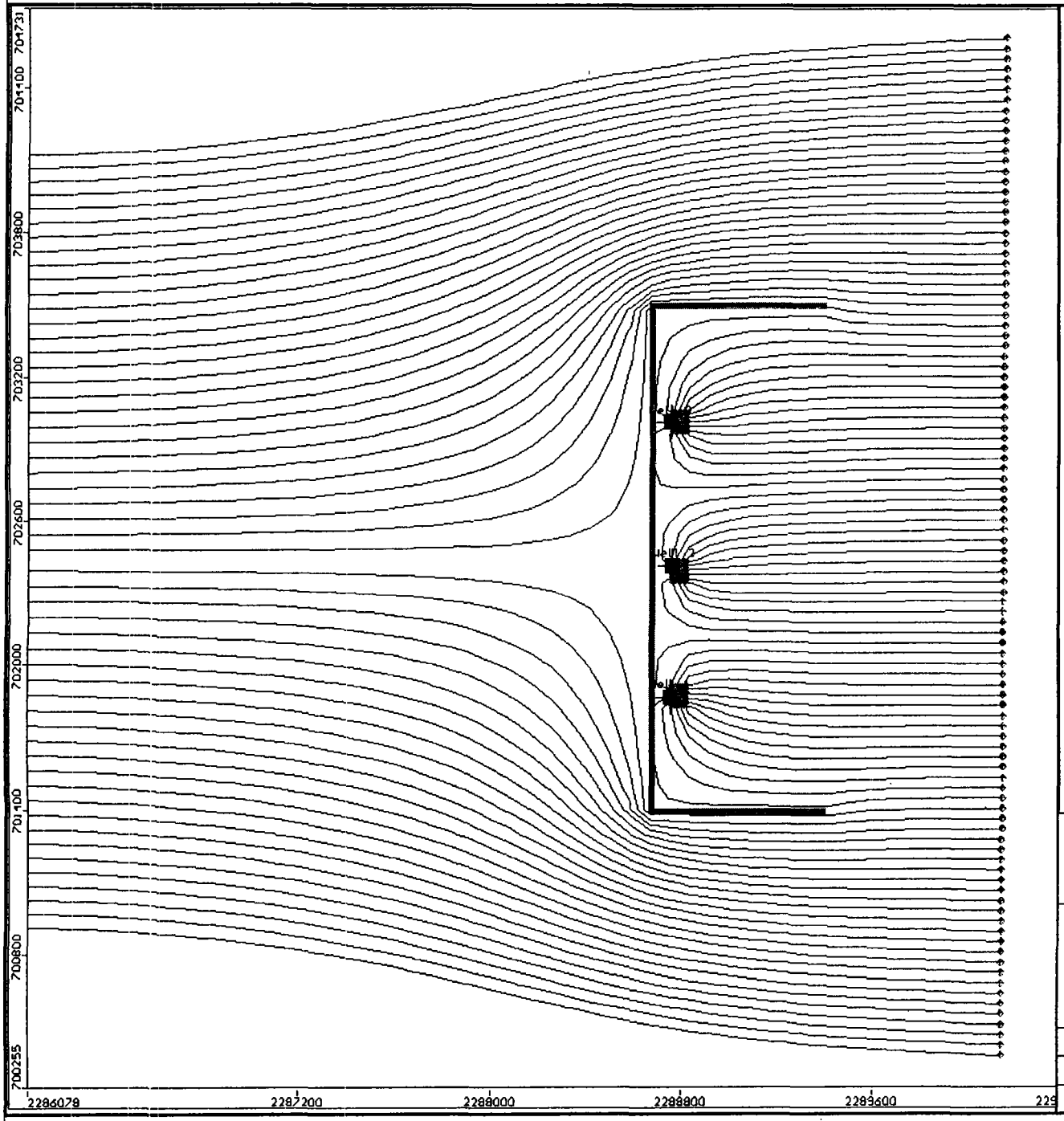
0 500

GROUNDWATER SERVICES, INC.

CASE 2: 6 FT GRADIENT
$Q_{IN} = Q_{OUT}$
(TOTAL Q = 1635 GPM)

Sauget and Cahokia, Illinois

GSI Job No.:	G-2898	Drawn by:	SKF	**Figure 5.17**
Issued:	04/1/05	Approved by:	CJN	
Scale:	As Shown	Revised:	--	



N

LEGEND

- Pumping Well
- Particle Flow Line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 6 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

0 500

GROUNDWATER SERVICES, INC.

CASE 3: 6 FT GRADIENT
$Q_{IN} > Q_{OUT}$
(TOTAL Q = 1535 GPM)

Sauget and Cahokia, Illinois

GSI Job No.:	G-2898	Drawn by:	SKF	**Figure 5.18**
Issued:	04/1/05	Approved by:	CJN	
Scale:	As Shown	Revised:	--	

ATTACHMENT 6

Estimated Flow through Barrier Wall

GSI Job No. G-2936
Issued: 11/15/04
Page 1 of 1
Preliminary

GROUNDWATER SERVICES, INC.

ESTIMATED FLOW RATE THROUGH BARRIER WALL
SAUGET AREA 2 GMCS, SAUGET ILLINOIS

Hydraulic Conductivity [1] K cm/s	Head *Difference* Across Wall dh ft	Wall Thickness[2] dL ft	Total Wall Area A ft^2	Darcy Velocity Vd cm/s	FLOW RATE Q gpm	*Travel Time* Through Wall t Years
1.40E-08	1	3	457,014	4.67E-09	0.03	124.2
1.40E-08	2	3	457,014	9.33E-09	0.06	62.1
1.40E-08	3	3	457,014	1.40E-08	0.09	41.4
1.40E-08	4	3	457,014	1.87E-08	0.13	31.0
1.40E-08	5	3	457,014	2.33E-08	0.16	24.8
1.40E-08	10	3	457,014	4.67E-08	0.31	12.4
1.40E-08	15	3	457,014	7.00E-08	0.47	8.3

Equations:

Darcy V = K * dh/dL
Flow Rate = Vd * A

Travel Time = dL / (Vd/ϕ)

Parameters

Hydraulic Conductivity[1]
K = 1.40E-08 cm/s

Estimated Effective Porosity
ϕ = 0.2

Wall Thickness[2]
dL = 3 ft

Barrier Wall Dimensions:

	Length[3] ft	Depth[4] ft	Area ft^2
North Wing	685	136.3	93365.5
Center	2036	136.3	277506.8
South Wing	632	136.3	86141.6
Total Area			457,014

Conversion factors

1 ft =	30.48	cm
1 min =	60	seconds
1 Year =	31,557,600	seconds
1 ft^3 =	7.48	gallons

1) *Hydraulic Conductivity supplied by Solutia*
2) Wall Thickness supplied by Solutia

3) Barrier Wall length measured from "Groundwater Migration Control System, Groundwater Elevation" drawing, dated May 09, 2004

4) Barrier Wall depth was average depth from file: "Bottom of Barrier Wall-Rock Depth Confirmation.xls" supplied by URS Corporation

GROUNDWATER SERVICES, INC.

TABLE 1
RESULTS OF PREDICTED PARTICLE PENETRATION CALCULATION
Solutia Site R Pizometer Monitoring: December 2004 - February 2005
St. Louis, Missouri

Pizometer Pair:	PZ-1	PZ-1	PZ-2	PZ-2	PZ-3	PZ-3	PZ-4	PZ-4
Value Type:	Height Change	Particle Location	Height Change	Particle Location	Height Change	Particle Location	Height Change	Particle Location
Date	ft	ft	ft	ft	ft	ft	ft	ft
Height Change Measurements and Particl Location Calculations								
12/01/04	-3.13	0.00	-3.48	0.00	-3.61	0.00	-2.62	0.00
12/02/04	-3.37	0.00	-3.03	0.00	-3.14	0.00	-2.35	0.00
12/03/04	-3.48	0.00	-2.34	0.00	-2.59	0.00	-2.06	0.00
12/04/04	-3.28	0.00	-1.80	0.00	-2.10	0.00	-1.85	0.00
12/05/04	-2.80	0.00	-0.77	0.00	-1.28	0.00	-1.30	0.00
12/06/04	-3.33	0.00	-1.50	0.00	-2.14	0.00	-2.00	0.00
12/07/04	-4.31	0.00	-3.60	0.00	-3.63	0.00	-2.81	0.00
12/08/04	-5.05	0.00	-5.33	0.00	-4.85	0.00	-3.47	0.00
12/09/04	-4.51	0.00	-4.48	0.00	-4.01	0.00	-2.88	0.00
12/10/04	-3.95	0.00	-3.55	0.00	-3.25	0.00	-2.35	0.00
12/11/04	-3.05	0.00	-1.96	0.00	-2.00	0.00	-1.61	0.00
12/12/04	-2.73	0.00	-1.03	0.00	-1.56	0.00	-1.28	0.00
12/13/04	-3.15	0.00	-1.15	0.00	-1.65	0.00	-1.66	0.00
12/14/04	-3.20	0.00	-1.02	0.00	-1.25	0.00	-1.31	0.00
12/15/04	-3.38	0.00	-0.84	0.00	-0.93	0.00	-1.04	0.00
12/16/04	-4.46	0.00	-1.68	0.00	-1.52	0.00	-1.60	0.00
12/17/04	-3.36	0.00	-0.50	0.00	-0.65	0.00	-0.94	0.00
12/18/04	-4.27	0.00	-0.96	0.00	-0.87	0.00	-1.14	0.00
12/19/04	-4.48	0.00	-1.29	0.00	-1.13	0.00	-1.39	0.00
12/20/04	-4.57	0.00	-1.09	0.00	-1.73	0.00	-1.70	0.00
12/21/04	-4.48	0.00	-0.97	0.00	-1.24	0.00	-1.68	0.00
12/22/04	-4.58	0.00	-0.63	0.00	-0.71	0.00	-1.37	0.00
12/23/04	-4.08	0.00	**0.62**	4.08E-05	-0.45	0.00	-1.76	0.00
12/24/04	-3.41	0.00	**1.80**	1.60E-04	**0.54**	3.58E-05	-1.16	0.00
12/25/04	-3.55	0.00	**1.58**	2.64E-04	**0.31**	5.62E-05	-1.22	0.00
12/26/04	-4.05	0.00	**0.72**	3.11E-04	-0.37	3.20E-05	-1.62	0.00
12/27/04	-4.09	0.00	**0.72**	3.59E-04	-0.40	5.51E-06	-1.59	0.00
12/28/04	-4.10	0.00	**0.60**	3.99E-04	-0.50	0.00	-1.66	0.00
12/29/04	-4.00	0.00	**0.80**	4.52E-04	-0.40	0.00	-1.60	0.00
12/30/04	-4.00	0.00	**0.77**	5.02E-04	-0.37	0.00	-1.60	0.00
12/31/04	-3.71	0.00	**1.25**	5.85E-04	**0.11**	7.17E-06	-1.33	0.00
01/01/05	-4.02	0	**0.85**	6.42E-04	-0.30	0	-1.55	0
01/02/05	-3.61	0	**1.44**	7.37E-04	**0.22**	1.46E-05	-1.22	0
01/03/05	-2.10	0	**1.59**	8.42E-04	**0.51**	4.85E-05	-0.55	0
01/04/05	-4.27	0	-3.30	6.23E-04	-3.35	*0*	*-2.18*	*0*
01/05/05	-7.16	0	-9.61	0	-8.26	0	-4.89	0
01/06/05	-10.47	0	-15.48	0	-12.72	0	-7.88	0
01/07/05	-10.39	0	-14.82	0	-12.21	0	-8.05	0
01/08/05	-8.03	0	-10.33	0	-8.61	0	-5.94	0
01/09/05	-6.35	0	-7.40	0	-6.34	0	-4.45	0
01/10/05	-5.20	0	-5.58	0	-4.82	0	-3.48	0
01/11/05	-4.06	0	-3.54	0	-3.30	0	-2.48	0
01/12/05	-4.14	0	*-4.56*	0	-3.30	0	-2.48	0
01/13/05	-5.56	0	-5.59	0	-5.11	0	-3.81	0
01/14/05	-7.08	0	-8.84	0	-7.44	0	-5.10	0
01/15/05	-6.73	0	-8.15	0	-6.87	0	-4.76	0
01/16/05	-4.85	0	-4.91	0	-4.30	0	-3.15	0
01/17/05	-3.00	0	*-7.41*	0	-3.01	0	-2.32	0
01/18/05	-1.15	0	**2.09**	1.38E-04	**1.53**	1.01E-04	-1.70	0
01/19/05	-1.97	0	-0.89	7.92E-05	-0.54	6.57E-05	-1.06	0
01/20/05	-1.93	0	-0.90	1.99E-05	-2.15	0	-1.27	0
01/21/05	-2.04	0	-0.91	0	-7.38	0	*-0.84*	0
01/22/05	-1.99	0	-0.94	0	-3.94	0	0.00	0
01/23/05	-1.70	0	-0.40	0	-2.72	0	0.00	0
01/24/05	-1.45	0	**0.24**	1.56E-05	-1.88	0	-1.23	0
01/25/05	-1.51	0	**0.22**	3.04E-05	-2.33	0	-1.02	0
01/26/05	-1.48	0	**0.29**	4.97E-05	-2.60	0	-1.04	0
01/27/05	-1.32	0	**0.68**	9.46E-05	-1.75	0	-1.04	0
01/28/05	-1.41	0	**0.95**	1.57E-04	-1.20	0	-0.97	0
01/29/05	-1.42	0	**0.96**	2.21E-04	-1.20	0	-0.97	0
01/30/05	-1.41	0	**0.98**	2.85E-04	-1.21	0	-0.95	0
01/31/05	-1.42	0	**1.01**	3.52E-04	-1.11	0	-0.95	0
02/01/05	-2.36	0	**0.55**	3.86E-04	-1.08	0	-0.94	0
02/02/05	-1.23	0	**2.42**	5.48E-04	**1.26**	8.35E-05	**0.89**	4.55E-05
02/03/05	1.13	7.50E-05	**4.93**	8.74E-04	**3.57**	3.20E-04	**2.42**	2.06E-04
02/04/05	-0.52	4.08E-05	**3.44**	1.10E-03	**2.12**	4.60E-04	**1.31**	2.92E-04
02/05/05	-3.97	0	**0.47**	1.13E-03	-0.38	4.35E-04	-0.59	2.53E-04
02/06/05	-4.18	0	**0.10**	**1.14E-03**	-0.45	4.04E-04	-0.51	2.19E-04
02/07/05	-4.10	0	-0.10	1.13E-03	-0.61	3.64E-04	-0.58	1.81E-04
02/08/05	-3.52	0	-0.37	1.11E-03	-0.95	3.01E-04	-0.67	1.37E-04
02/09/05	-3.38	0	-0.43	1.08E-03	-1.02	2.34E-04	-0.66	9.34E-05
02/10/05	-3.13	0	-0.57	1.04E-03	-1.18	1.56E-04	-0.75	4.38E-05
02/11/05	-2.84	0	-0.65	1.00E-03	-1.27	7.18E-05	-0.77	0
02/12/05	-2.91	0	-0.60	9.60E-04	-1.24	0	-0.76	0
02/13/05	-2.99	0	-0.61	9.20E-04	-1.20	0	-0.81	0
02/14/05	*-2.88*	*0*	-2.14	7.79E-04	*-2.56*	*0*	*-1.34*	*0*
02/15/05	-4.49	0	-5.09	4.42E-04	-4.89	0	-2.67	0
02/16/05	-5.38	0	-6.62	4.18E-06	-6.16	0	-3.44	0
02/17/05	-5.06	0	-6.04	0	-5.70	0	-3.13	0
02/18/05	-4.33	0	-4.83	0	-4.66	0	-2.44	0
02/19/05	-3.82	0	-3.89	0	-3.87	0	-1.85	0
02/20/05	-3.02	0	-2.54	0	-2.77	0	-1.30	0
02/21/05	-2.37	0	-1.38	0	-1.88	0	-0.90	0
02/22/05	-2.38	0	-0.84	0	**0.15**	1.02E-05	-0.88	0
02/23/05	-2.55	0	-0.78	0	-1.47	0	-0.86	0
02/24/05	-2.83	0	-0.58	0	-1.01	0	-0.78	0
02/25/05	-3.24	0	-0.40	0	-0.74	0	-0.71	0
02/26/05	-3.56	0	-0.30	0	-0.73	0	-0.64	0
02/27/05	-3.64	0	-0.30	0	-0.71	0	-0.64	0
02/28/05	-3.73	0	-0.21	0	-0.68	0	-0.58	0

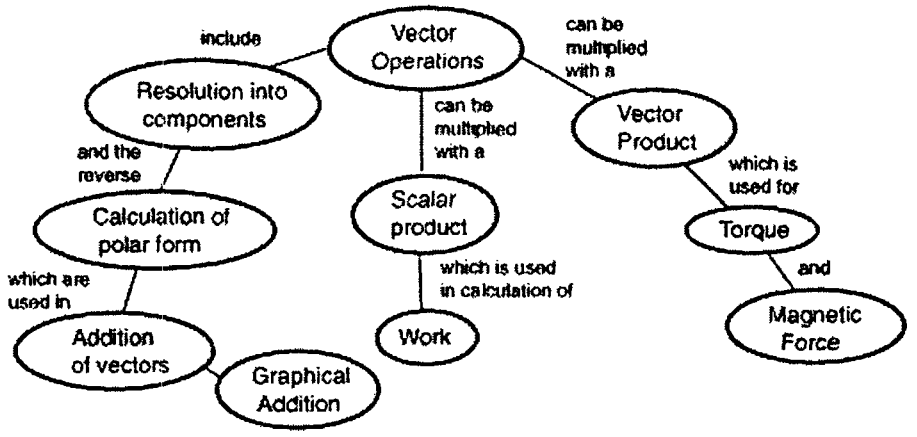
Notes:
1. *Values marked in bold denote days of positive groundwater flux through the berm*
2. Values marked in italics are height change values that were interpolated when measurement was unavailat
3. Maximum penetration value of 1.14×10^{-3} ft is in bold and boxed in heavier liner

ATTACHMENT 7

Particle Flow Paths Released on Upgradient Side of Barrier Wall

Basic Vector Operations

Both a magnitude and a direction must be specified for a vector quantity, in contrast to a scalar quantity which can be quantified with just a number. Any number of vector quantities of the same type (i.e., same units) can be combined by basic vector operations.



Caution! This is a large HTML document. You need to wait for it to load completely in order for all the links above to operate.

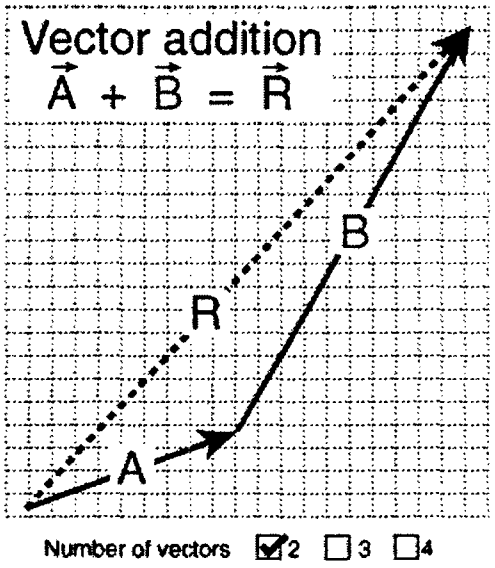
Index

Math of vectors

HyperPhysics***** Mechanics *R Nave*

Go Back

Vector Addition, Two Vectors



Vector addition involves finding vector components, adding them and finding the polar form of the resultant.

The addition of vector
A=36 at 270 degrees,
and vector
B=25.8 at 66 degrees,

yields components:

$$A_x + B_x = R_x$$
$$-6.613 + 10.49 = 10.49$$
$$A_y + B_y = R_y$$
$$-0.000 + 23.56 = 23.56$$

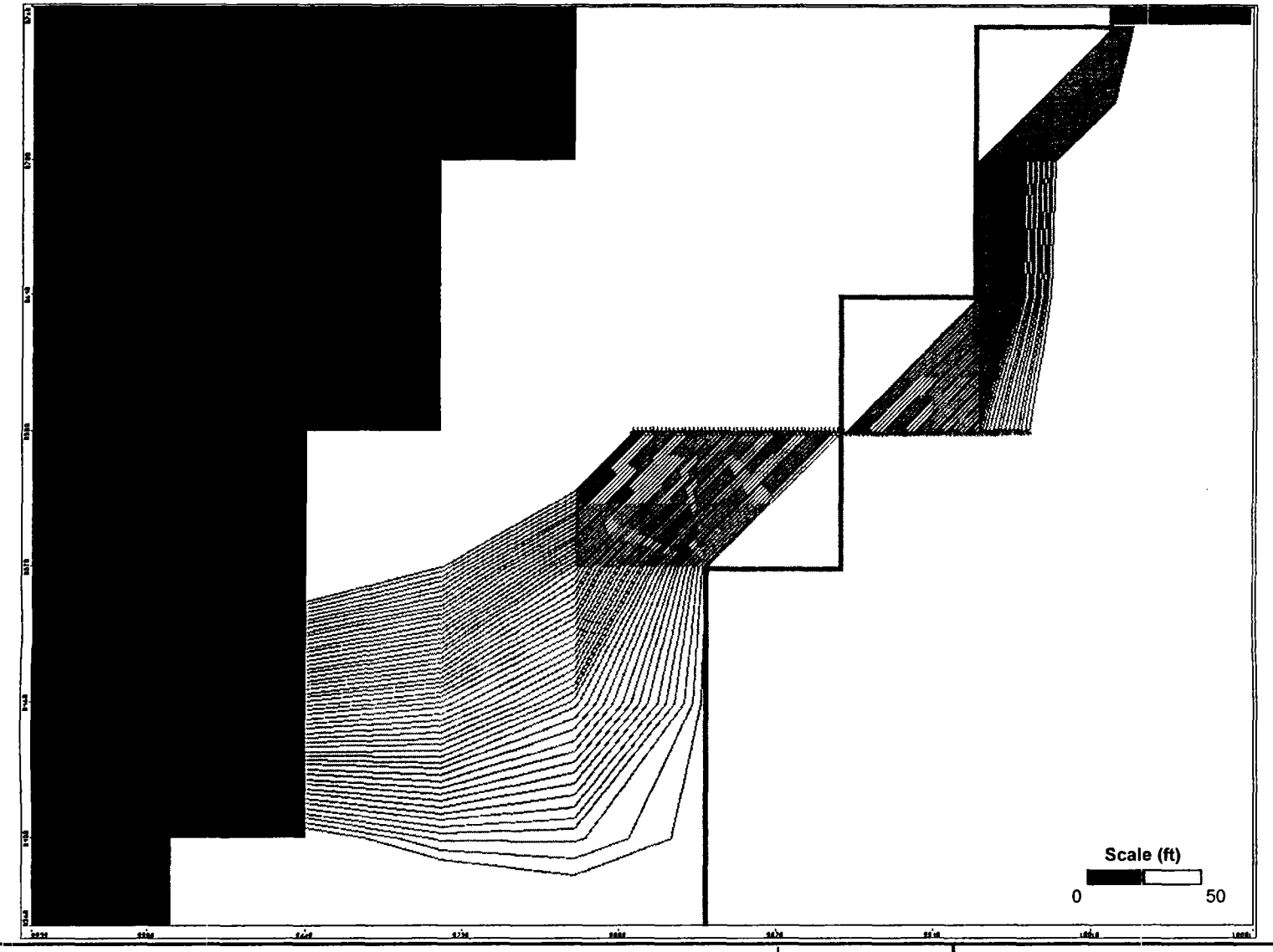
The resultant has magnitude
R = 25.79967
and angle
= 65.99967 degrees.

Index

Vector concepts

HyperPhysics***** Mechanics *R Nave*

Go Back



LEGEND

- Modflow particle flow line
- Modflow river cell
- Barrier wall
- Particle location

NOTES:

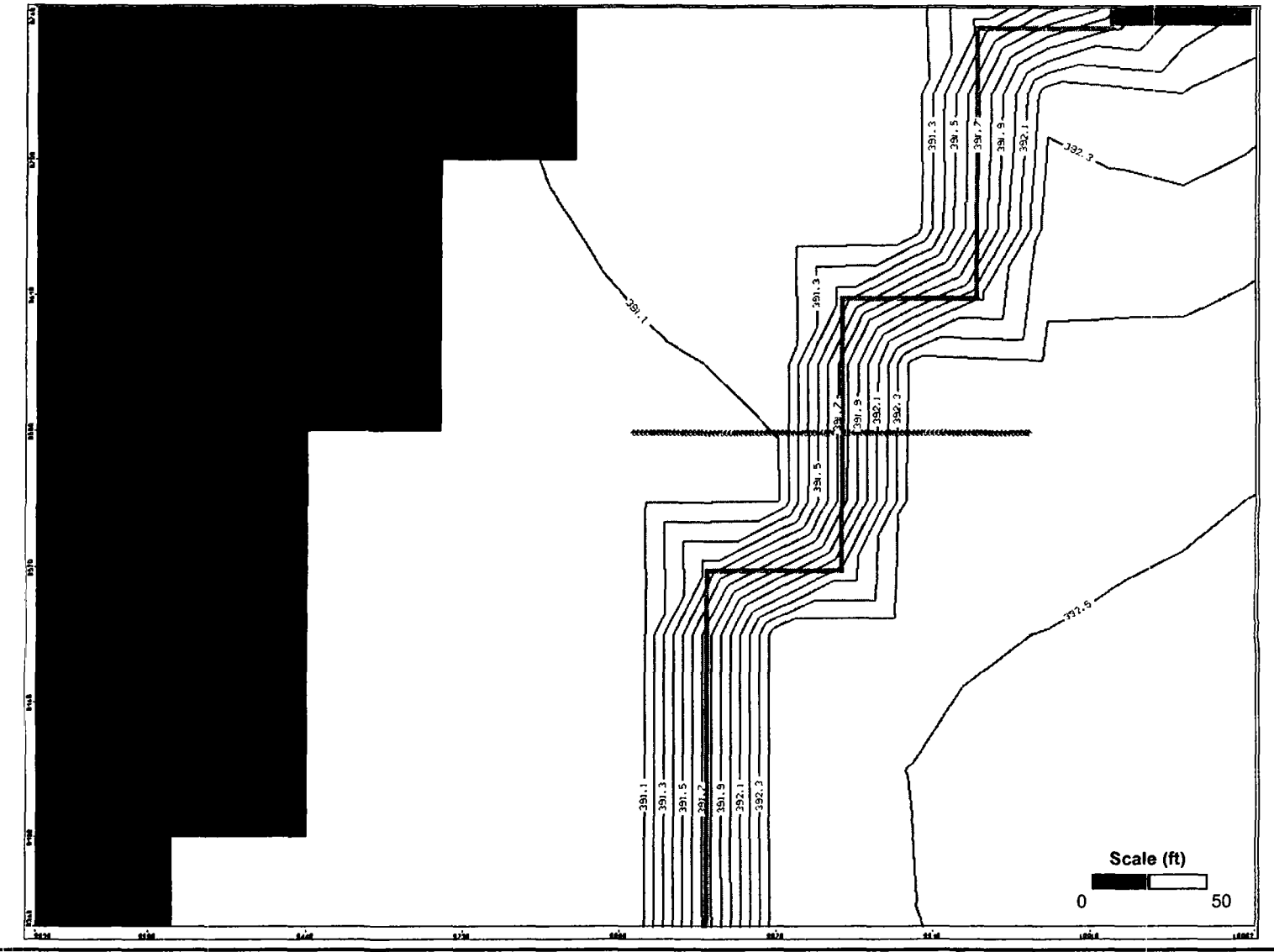
1. Output from Visual MODFLOW model.
2. Model assumes an average river stage of 391 ft MSL and three pumping wells.

GROUNDWATER SERVICES, INC.

EXISTING MODEL
$Q_{IN} = Q_{OUT}$
(TOTAL Q = 438 GPM)

GSI Job No.:	G-2898	Drawn by:	SKF
Issued:	04/1/05	Approved by:	CJN
Scale:	As Shown	Revised:	--

Figure 7.1



LEGEND

- Equipotential line
- Modflow river cell
- Barrier wall
- Particle location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes an average river stage of 391 ft MSL and three pumping wells.

GROUNDWATER SERVICES, INC.

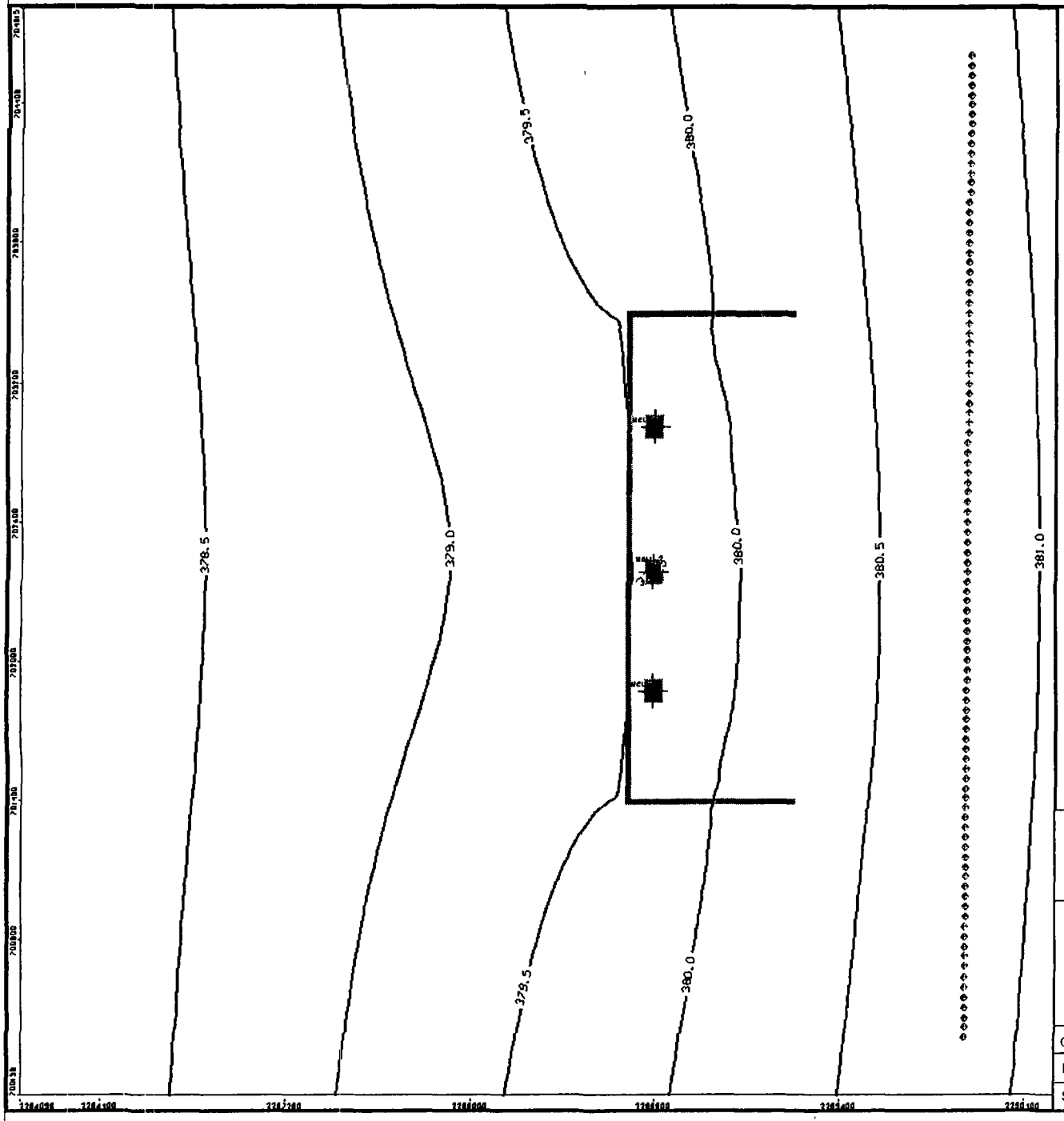
EXISTING MODEL
$Q_{IN} = Q_{OUT}$
(TOTAL Q = 438 GPM)

GSI Job No.:	G-2898	Drawn by:	SKF
Issued:	04/1/05	Approved by:	CJN
Scale:	As Shown	Revised:	--

Figure 7.2

ATTACHMENT 8

Effect of Pumping Rates on Equipotential Lines at a U-Shaped Barrier Wall



N

LEGEND

- Pumping Well
- 374.0 — Equipotential line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 1 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

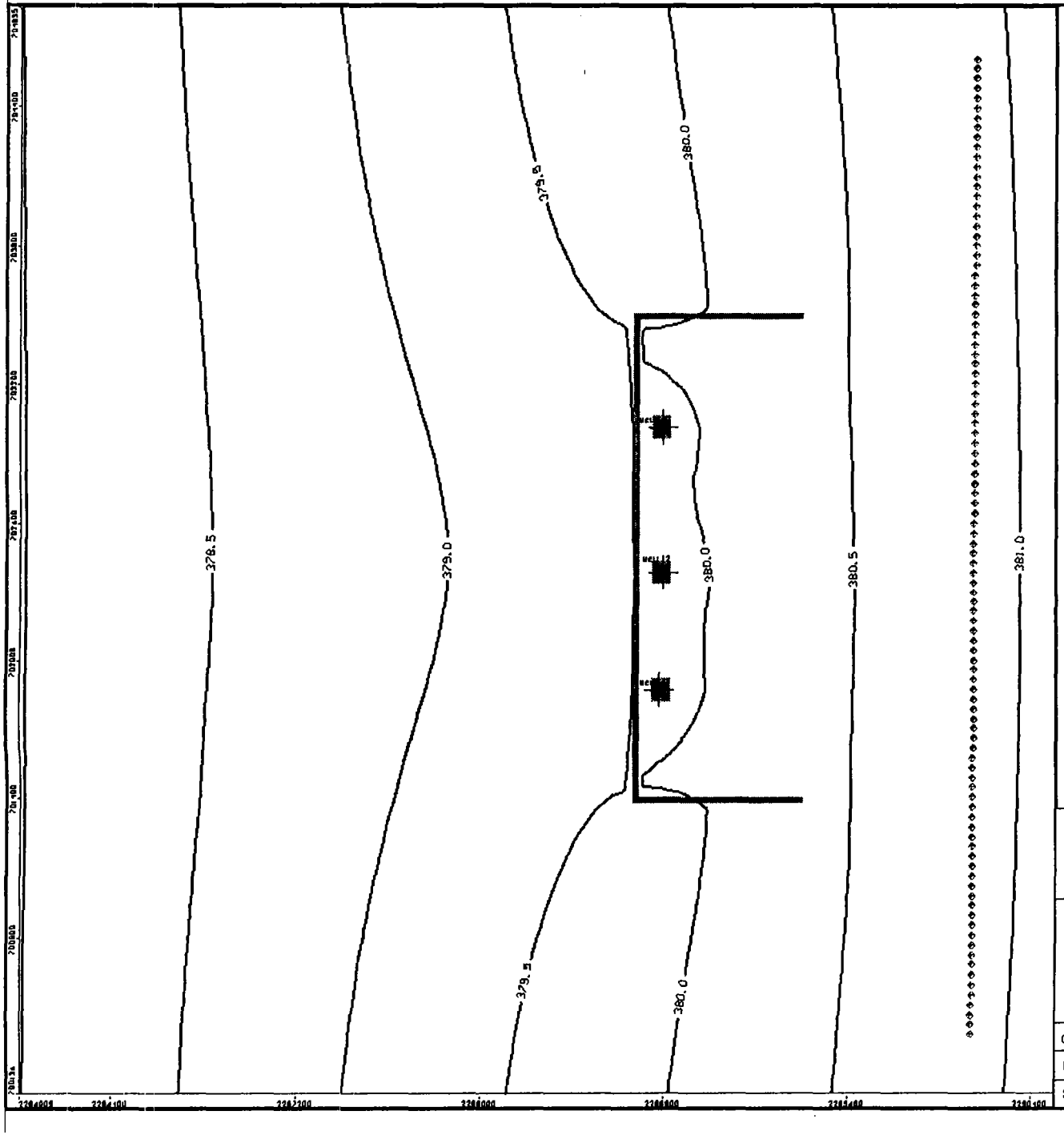
0 500

GROUNDWATER SERVICES, INC.

CASE 1: 1 FT GRADIENT
$Q_{IN} < Q_{OUT}$
(TOTAL Q = 295 GPM)

Sauget and Cahokia, Illinois

GSI Job No.: G-2898	Drawn by: SKF	**Figure 8.1**
Issued: 04/1/05	Approved by: CJN	
Scale: As Shown	Revised: --	



N

LEGEND

- Pumping Well
- 374.0 — Equipotential line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 1 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

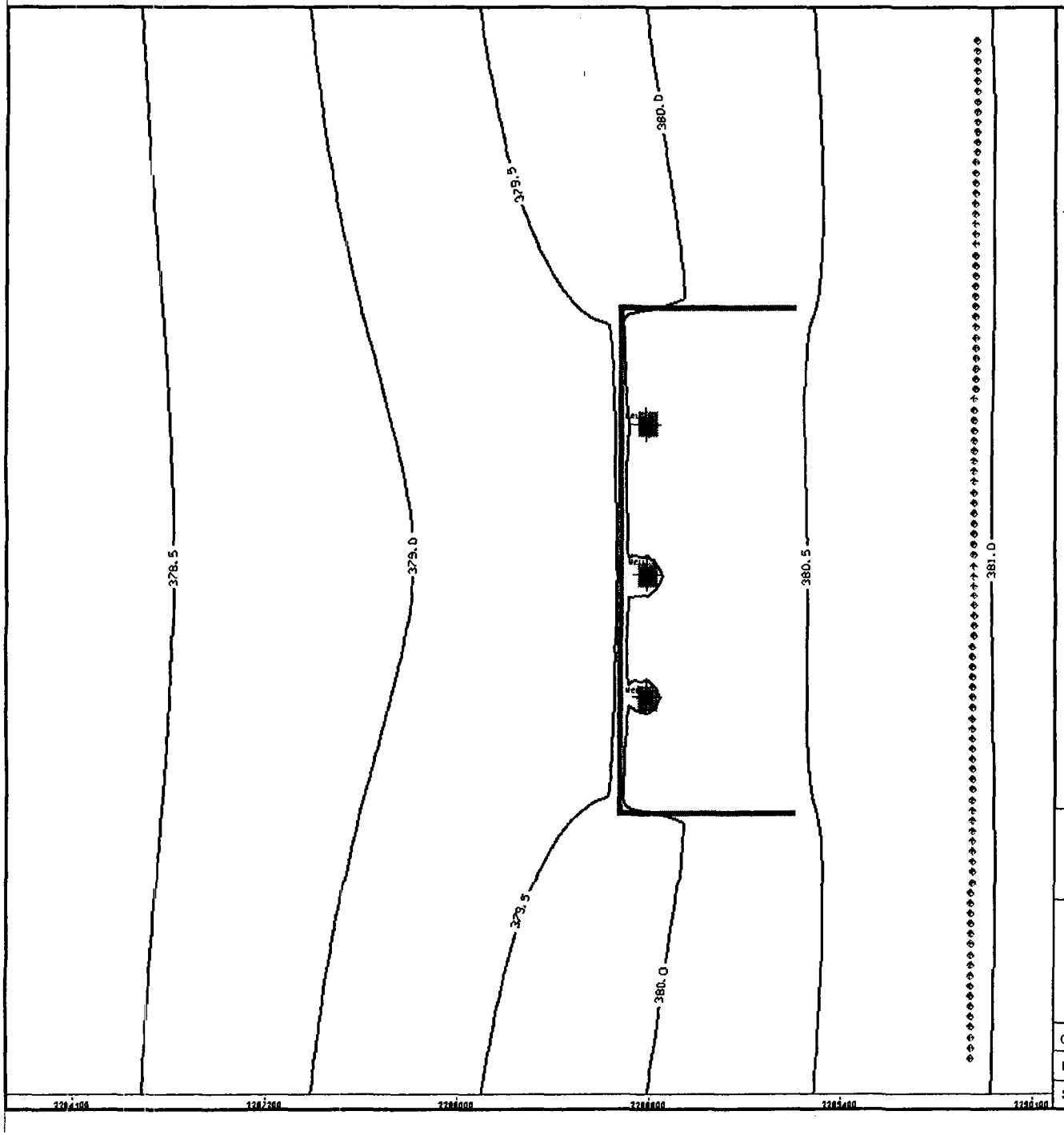
0 500

GROUNDWATER SERVICES, INC.

CASE 2: 1 FT GRADIENT
$Q_{IN} = Q_{OUT}$
(TOTAL Q = 265 GPM)

Sauget and Cahokia, Illinois

GSI Job No.:	G-2898	Drawn by:	SKF	**Figure 8.2**
Issued:	04/1/05	Approved by:	CJN	
Scale:	As Shown	Revised:	--	



N

LEGEND

- Pumping Well
- 374.0 — Equipotential line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 1 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

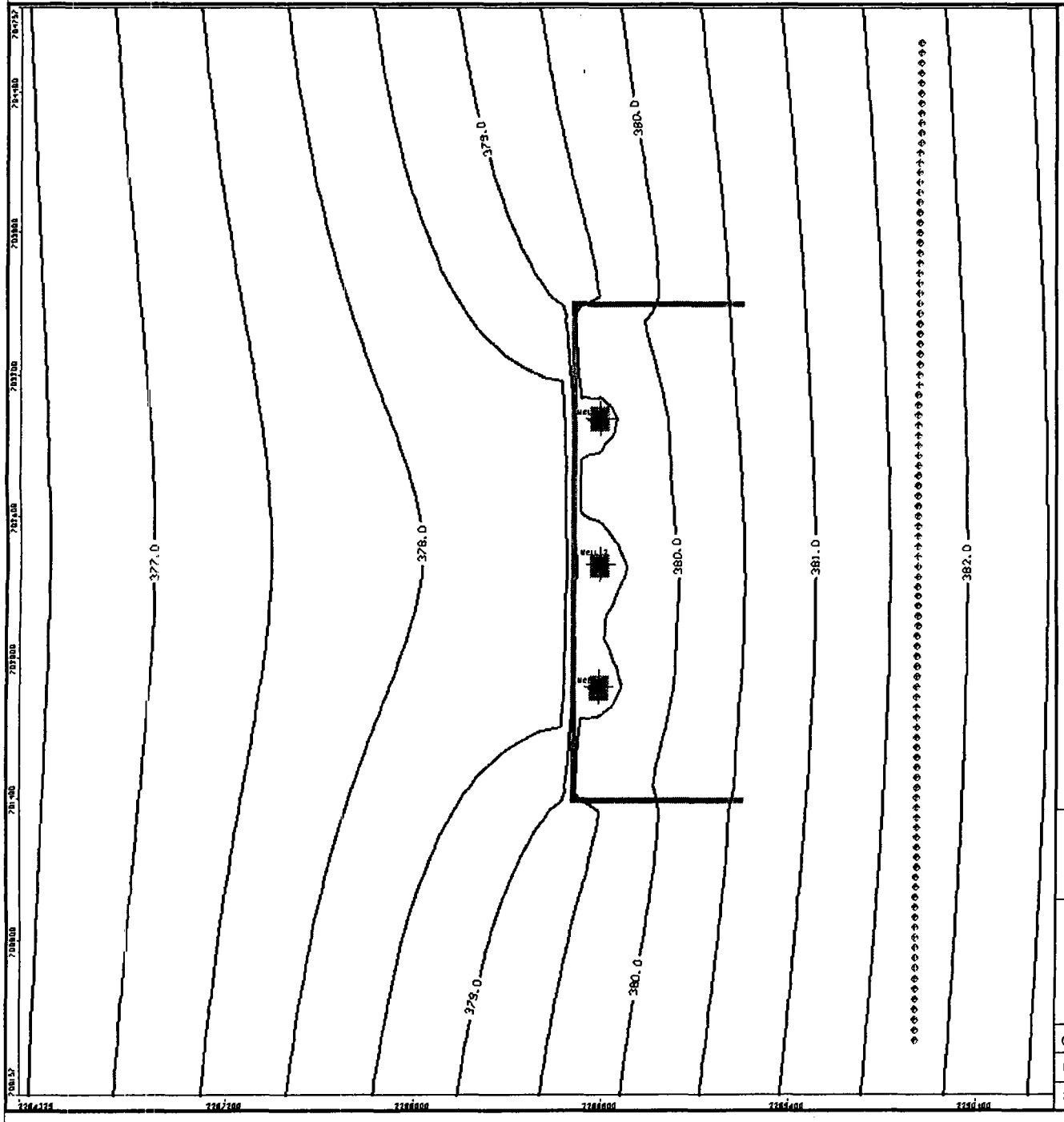
0 500

GROUNDWATER SERVICES, INC.

CASE 3: 1 FT GRADIENT
$Q_{IN} > Q_{OUT}$
(TOTAL Q = 235 GPM)

Sauget and Cahokia, Illinois

GSI Job No.: G-2898	Drawn by: SKF	**Figure 8.3**
Issued: 04/1/05	Approved by: CJN	
Scale: As Shown	Revised: --	



N

LEGEND

- Pumping Well
- 374.0 — Equipotential line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 2 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

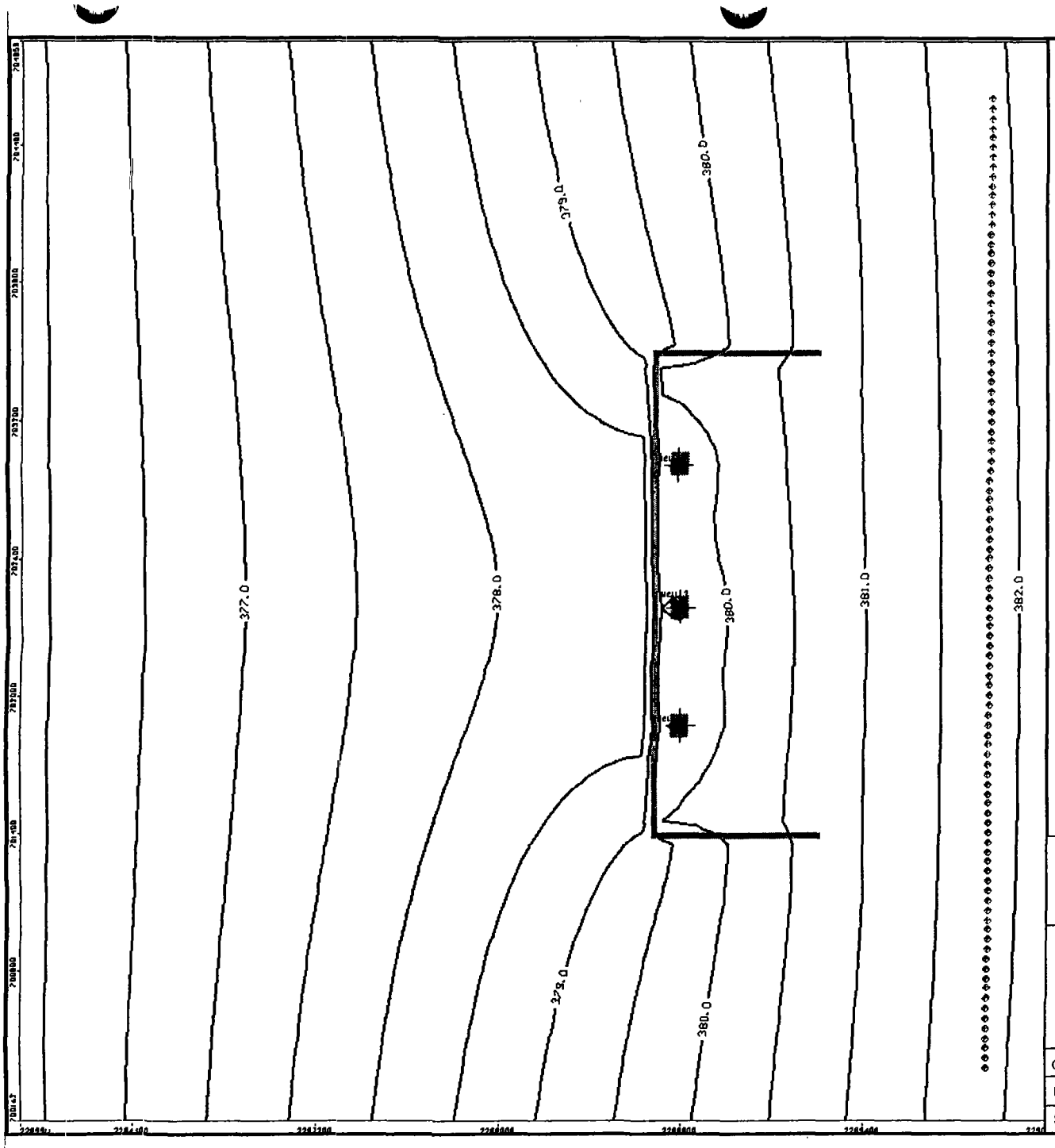
Scale (ft)

0 500

GROUNDWATER SERVICES, INC.

CASE 1: 2 FT GRADIENT
$Q_{IN} < Q_{OUT}$
(TOTAL Q = 588 GPM)

GSI Job No.: G-2898	Drawn by: SKF	**Figure 8.4**
Issued: 04/1/05	Approved by: CJN	
Scale: As Shown	Revised: --	



N

LEGEND

- Pumping Well
- 374.0 — Equipotential line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 2 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

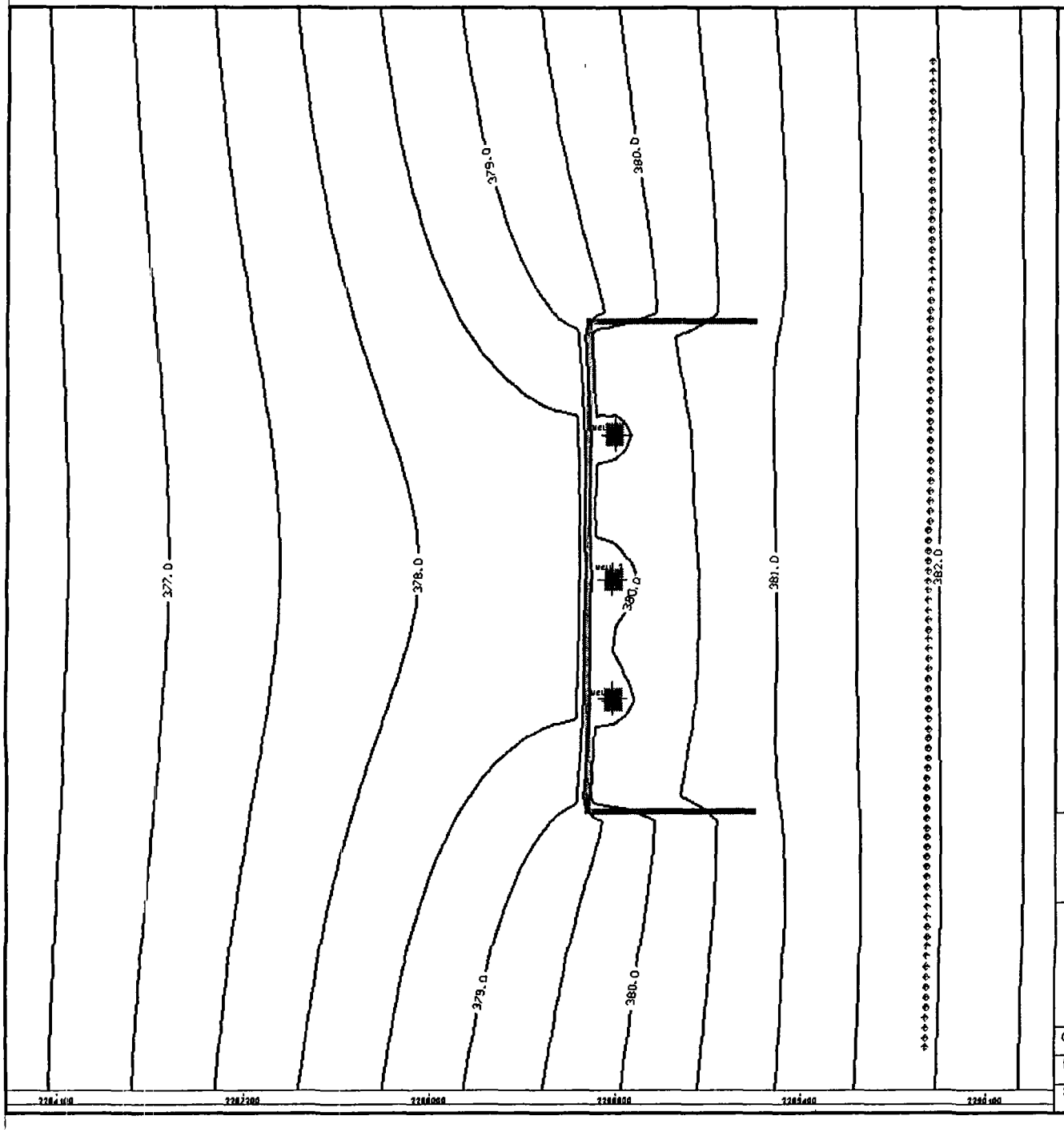
0 500

GROUNDWATER SERVICES, INC.

CASE 2: 2 FT GRADIENT
$Q_{IN} = Q_{OUT}$
(TOTAL Q = 543 GPM)

Sauget and Cahokia, Illinois

GSI Job No.: G-2898	Drawn by: SKF	**Figure 8.5**
Issued: 04/1/05	Approved by: CJN	
Scale: As Shown	Revised: --	



N

LEGEND

- Pumping Well
- 374.0 — Equipotential line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 2 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

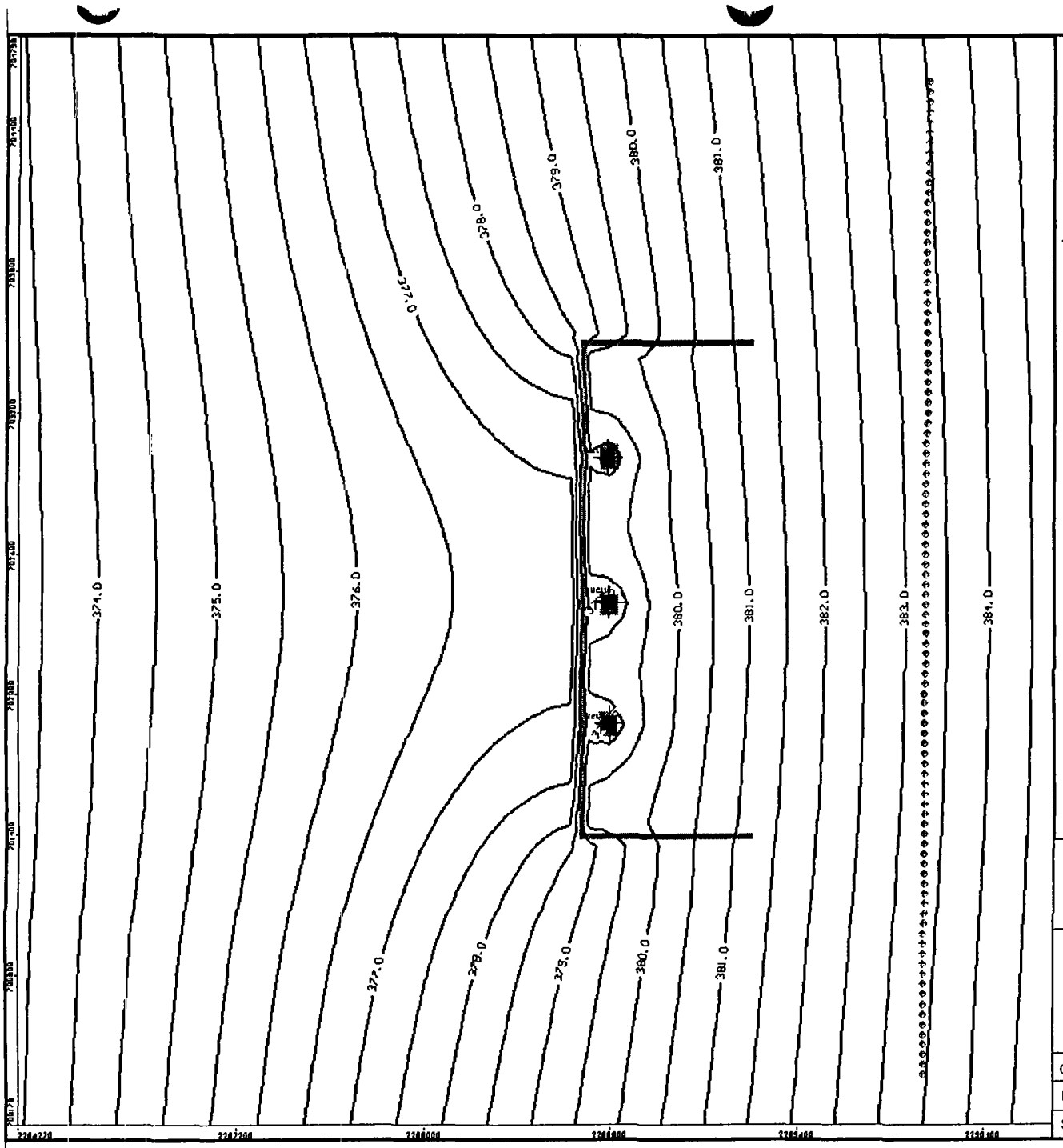
Scale (ft)
0 500

GROUNDWATER SERVICES, INC.

CASE 3: 2 FT GRADIENT
$Q_{IN} > Q_{OUT}$
(TOTAL Q = 498 GPM)

Sauget and Cahokia, Illinois

GSI Job No.:	G-2898	Drawn by:	SKF	Figure 8.6
Issued:	04/1/05	Approved by:	CJN	
Scale:	As Shown	Revised:	--	



N

LEGEND

- Pumping Well
- 374.0 — Equipotential line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 3 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

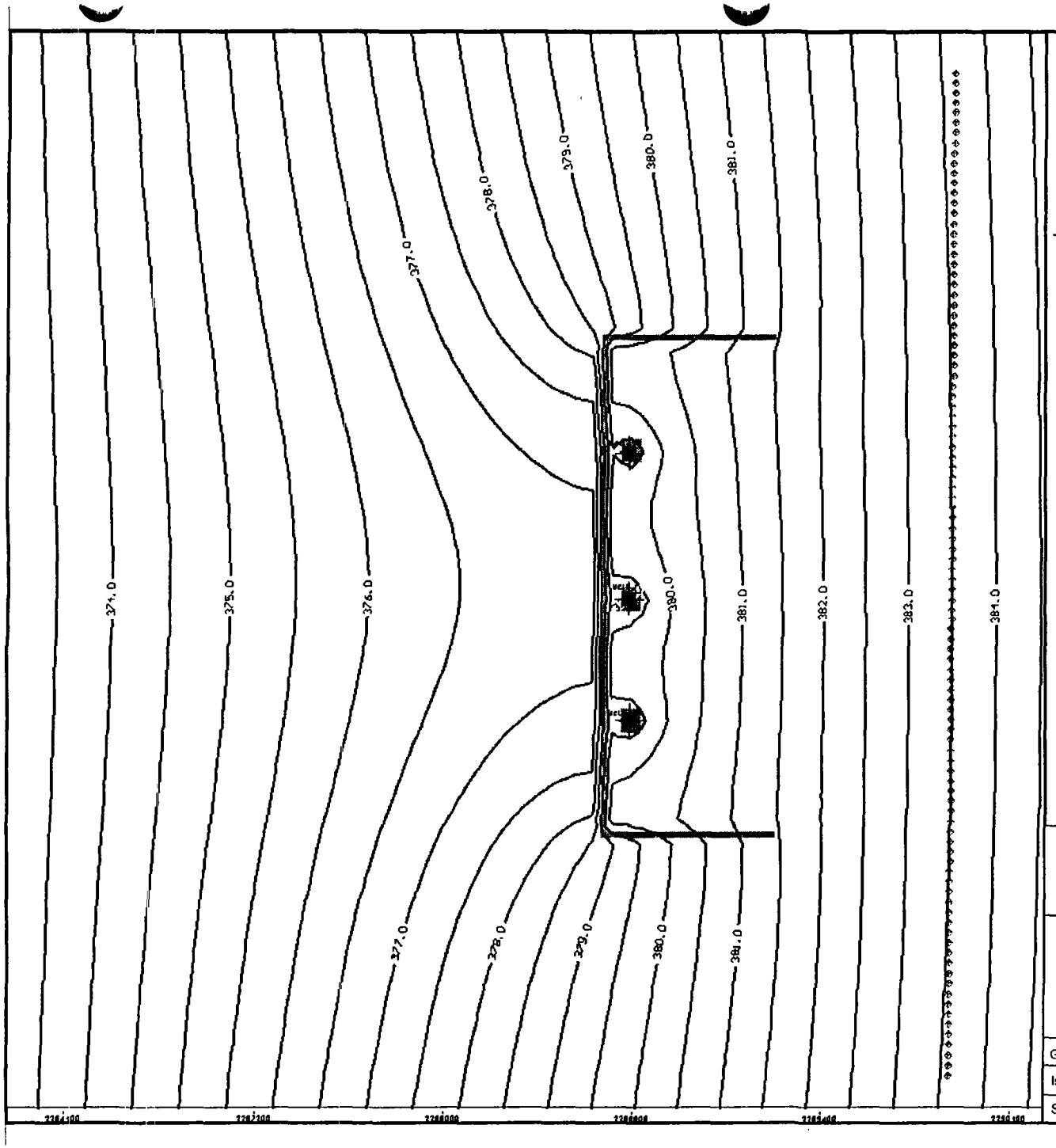
0 500

GROUNDWATER SERVICES, INC.

CASE 1: 3 FT GRADIENT
$Q_{IN} < Q_{OUT}$
(TOTAL Q = 1086 GPM)

Sauget and Cahokia, Illinois

GSI Job No.: G-2898	Drawn by: SKF		Figure 8.7
Issued: 04/1/05	Approved by: CJN		
Scale: As Shown	Revised: --		



N

LEGEND

- Pumping Well
- 374.0 — Equipotential line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 3 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

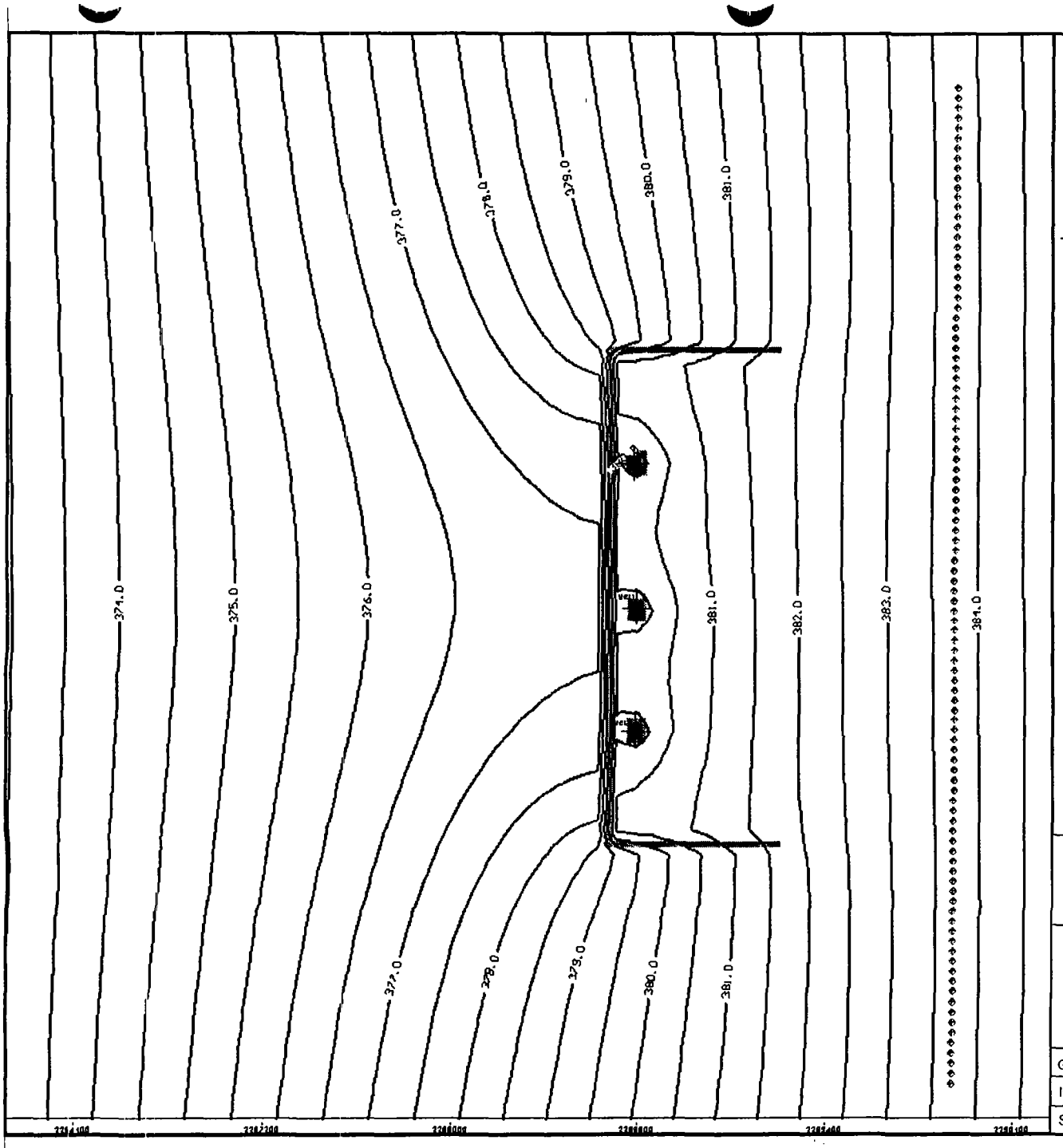
Scale (ft)
0 500

GROUNDWATER SERVICES, INC.

CASE 2: 3 FT GRADIENT
$Q_{IN} = Q_{OUT}$
(TOTAL Q = 996 GPM)

Sauget and Cahokia, Illinois

GSI Job No.:	G-2898	Drawn by:	SKF	**Figure 8.8**
Issued:	04/1/05	Approved by:	CJN	
Scale:	As Shown	Revised:	--	



LEGEND

- Pumping Well
- 374.0 — Equipotential line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 3 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

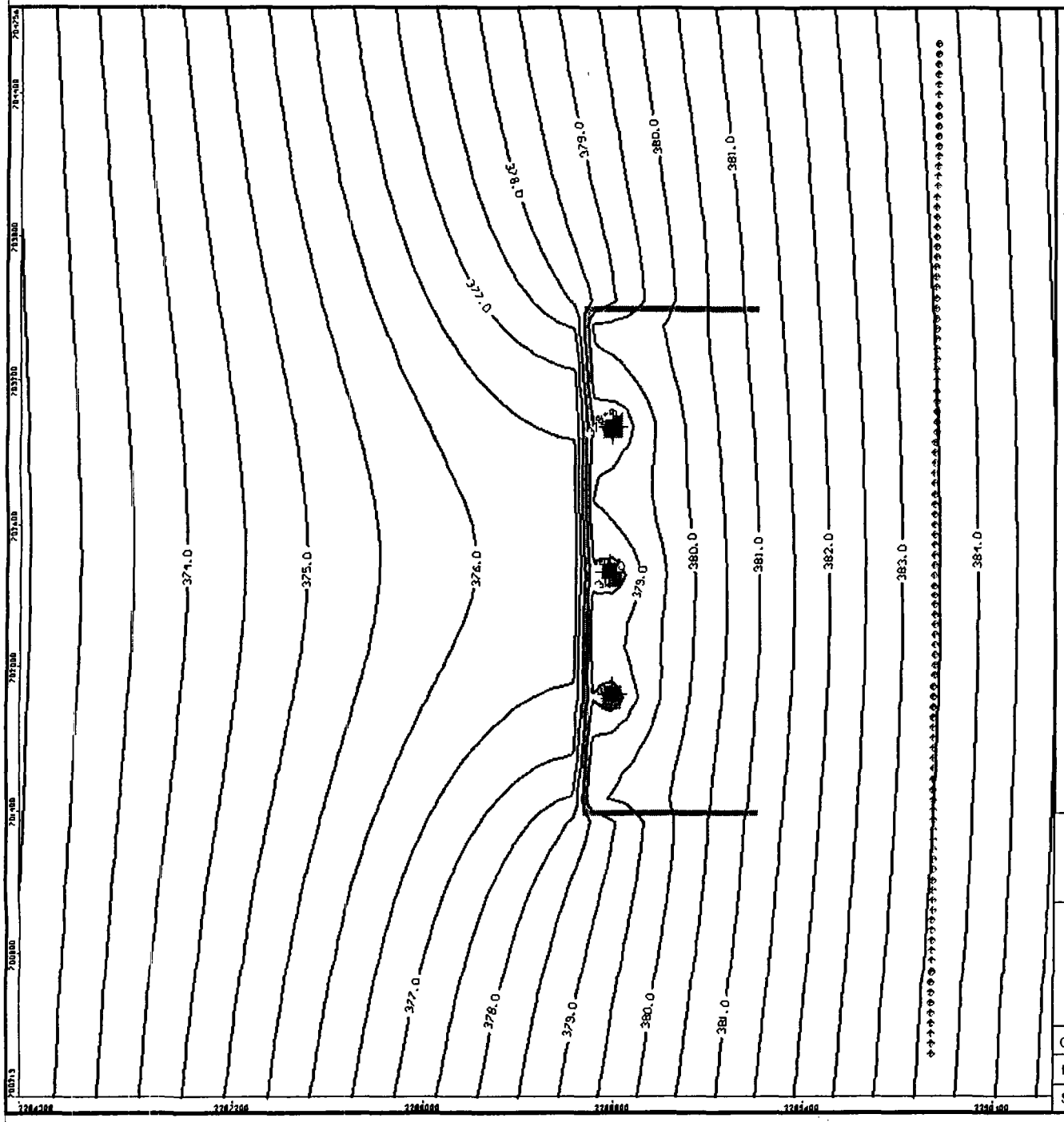
0 500

GROUNDWATER SERVICES, INC.

CASE 3: 3 FT GRADIENT
$Q_{IN} > Q_{OUT}$
(TOTAL Q = 906 GPM)

Sauget and Cahokia, Illinois

GSI Job No.: G-2898	Drawn by: SKF	**Figure 8.9**
Issued: 04/1/05	Approved by: CJN	
Scale: As Shown	Revised: --	



N

LEGEND

- Pumping Well
- 374.0 — Equipotential line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 4 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

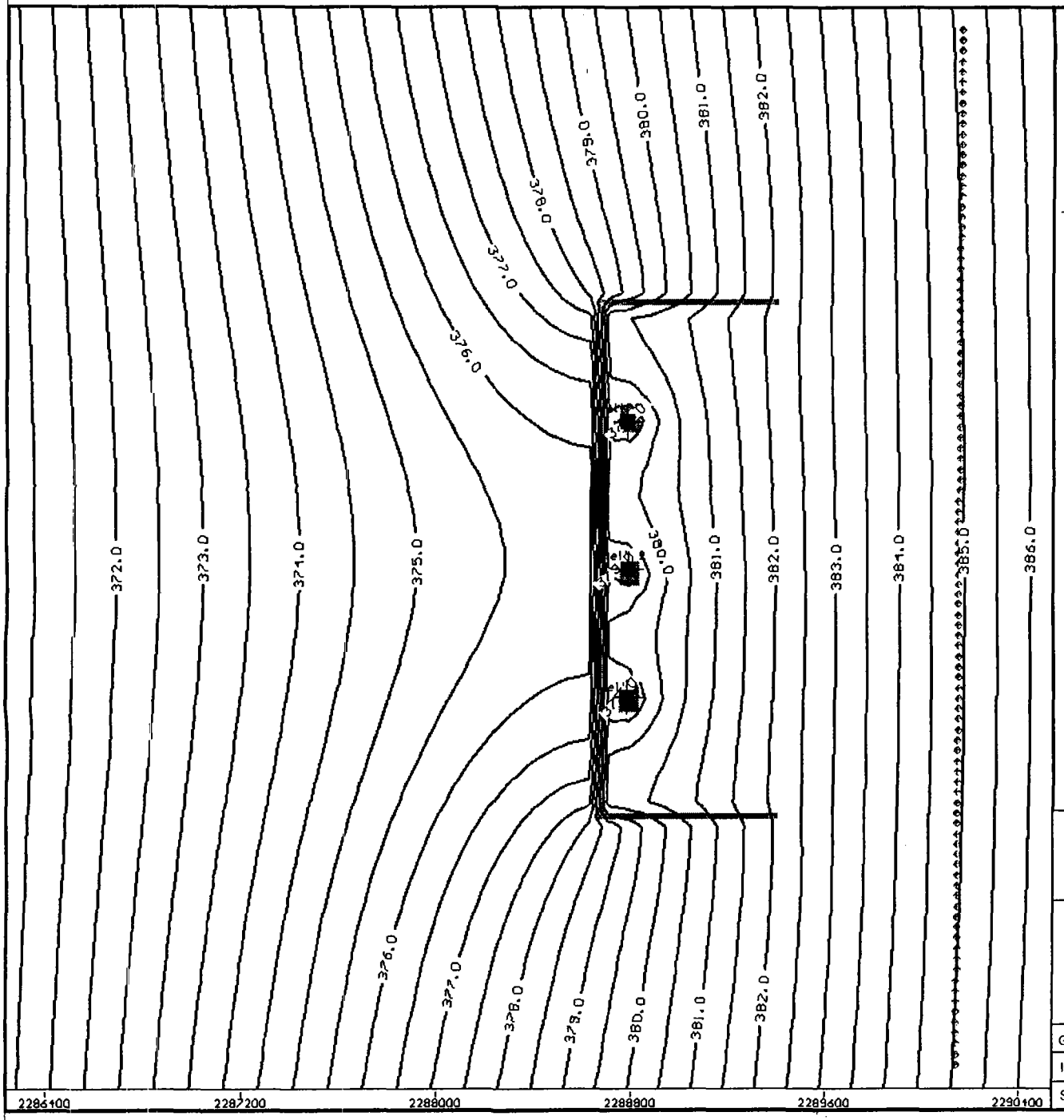
0 500

GROUNDWATER SERVICES, INC.

CASE 1: 4 FT GRADIENT
$Q_{IN} < Q_{OUT}$
(TOTAL Q = 1209 GPM)

Sauget and Cahokia, Illinois

GSI Job No.: G-2898	Drawn by: SKF	**Figure 8.10**
Issued: 04/1/05	Approved by: CJN	
Scale: As Shown	Revised: --	



N

LEGEND

- Pumping Well
- 374.0 — Equipotential line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 4 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

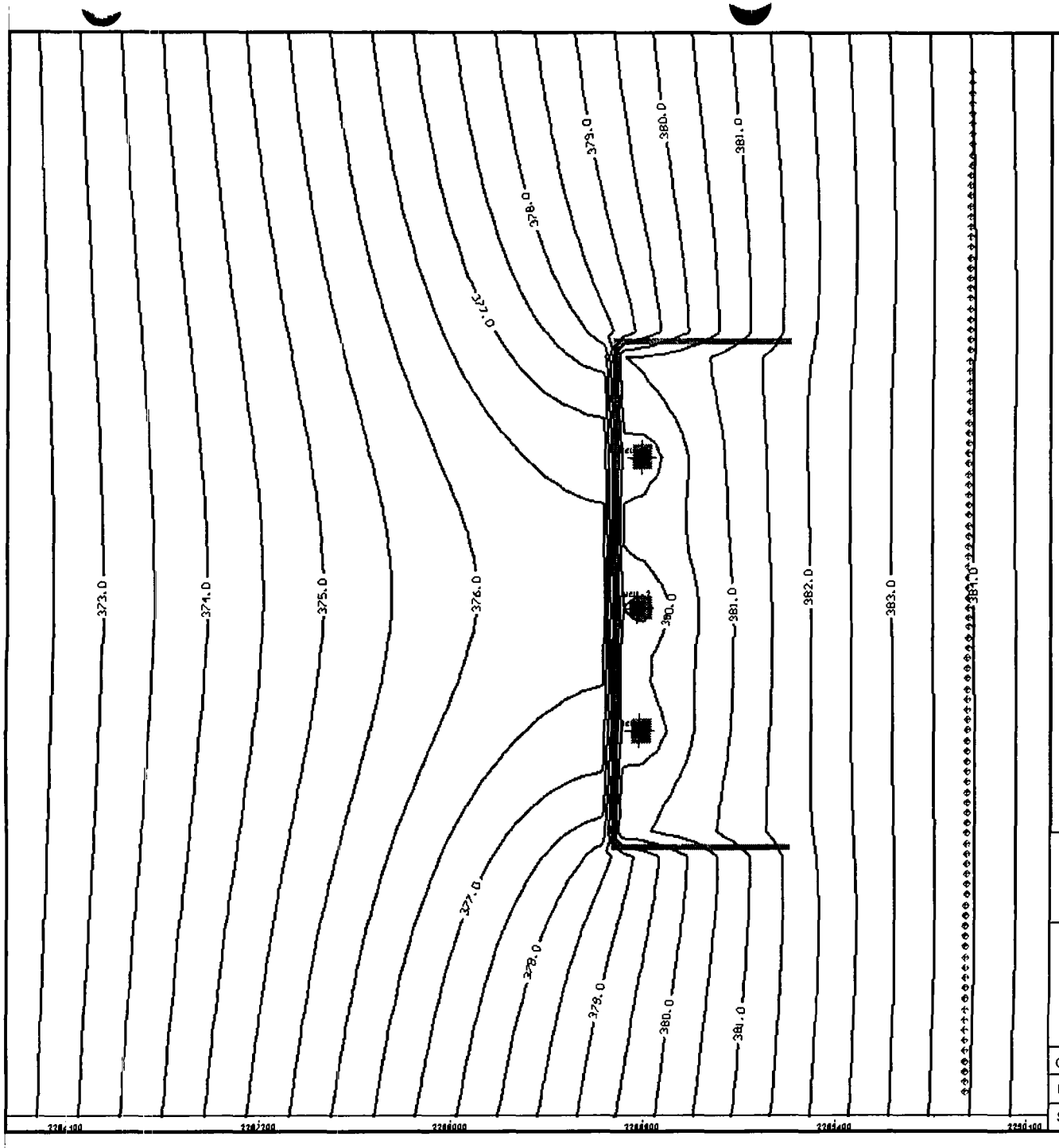
0 500

GROUNDWATER SERVICES, INC.

CASE 2: 4 FT GRADIENT
$Q_{IN} = Q_{OUT}$
(TOTAL Q = 1119 GPM)

Sauget and Cahokia, Illinois

GSI Job No.: G-2898	Drawn by: SKF	**Figure 8.11**
Issued: 04/1/05	Approved by: CJN	
Scale: As Shown	Revised: --	



N

LEGEND

- Pumping Well
- 374.0 — Equipotential line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 4 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

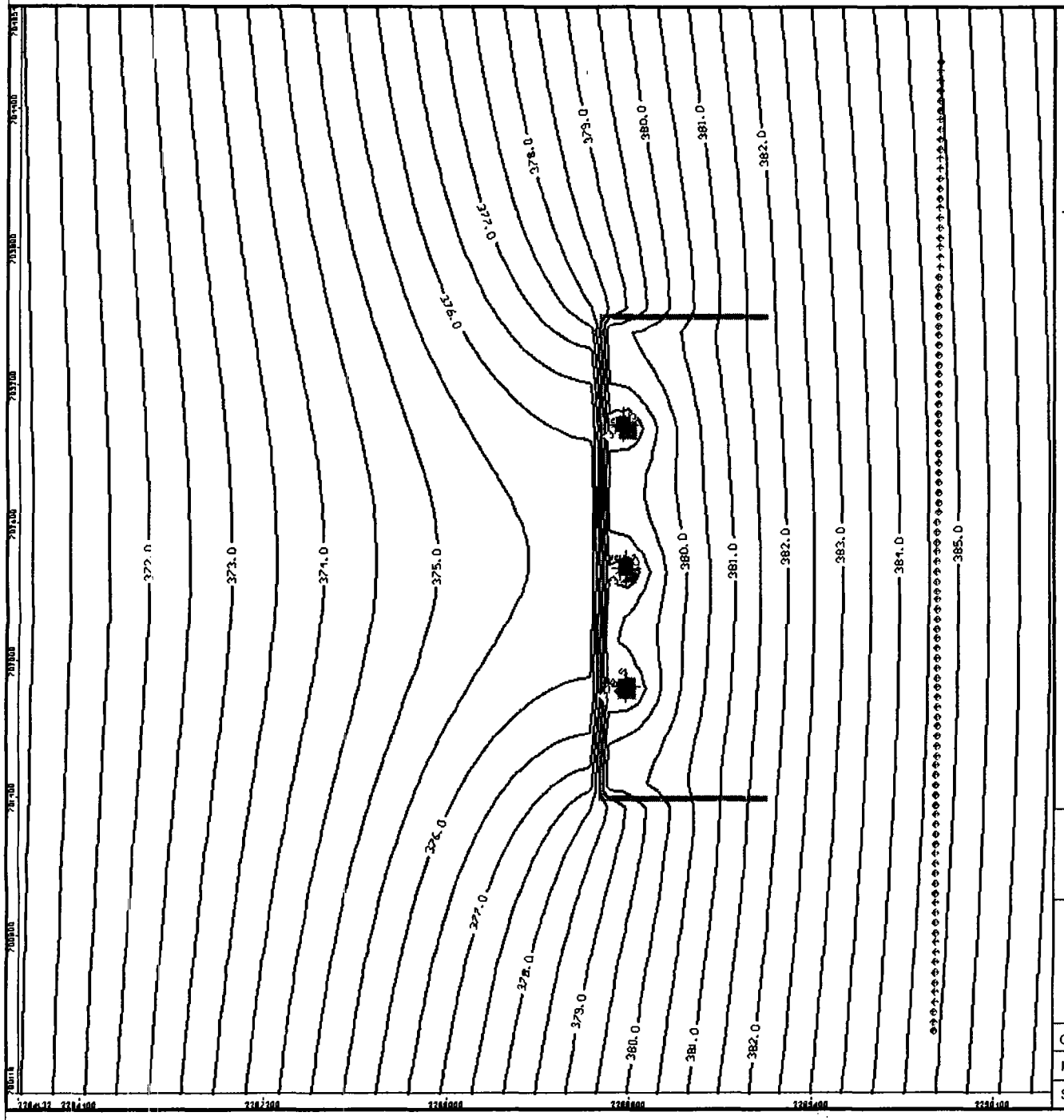
0 500

GROUNDWATER SERVICES, INC.

CASE 3: 4 FT GRADIENT
$Q_{IN} > Q_{OUT}$
(TOTAL Q = 1029 GPM)

Sauget and Cahokia, Illinois

GSI Job No.:	G-2898	Drawn by:	SKF	**Figure 8.12**
Issued:	04/1/05	Approved by:	CJN	
Scale:	As Shown	Revised:	--	



N

LEGEND

- Pumping Well
- 374.0 — Equipotential line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 5 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

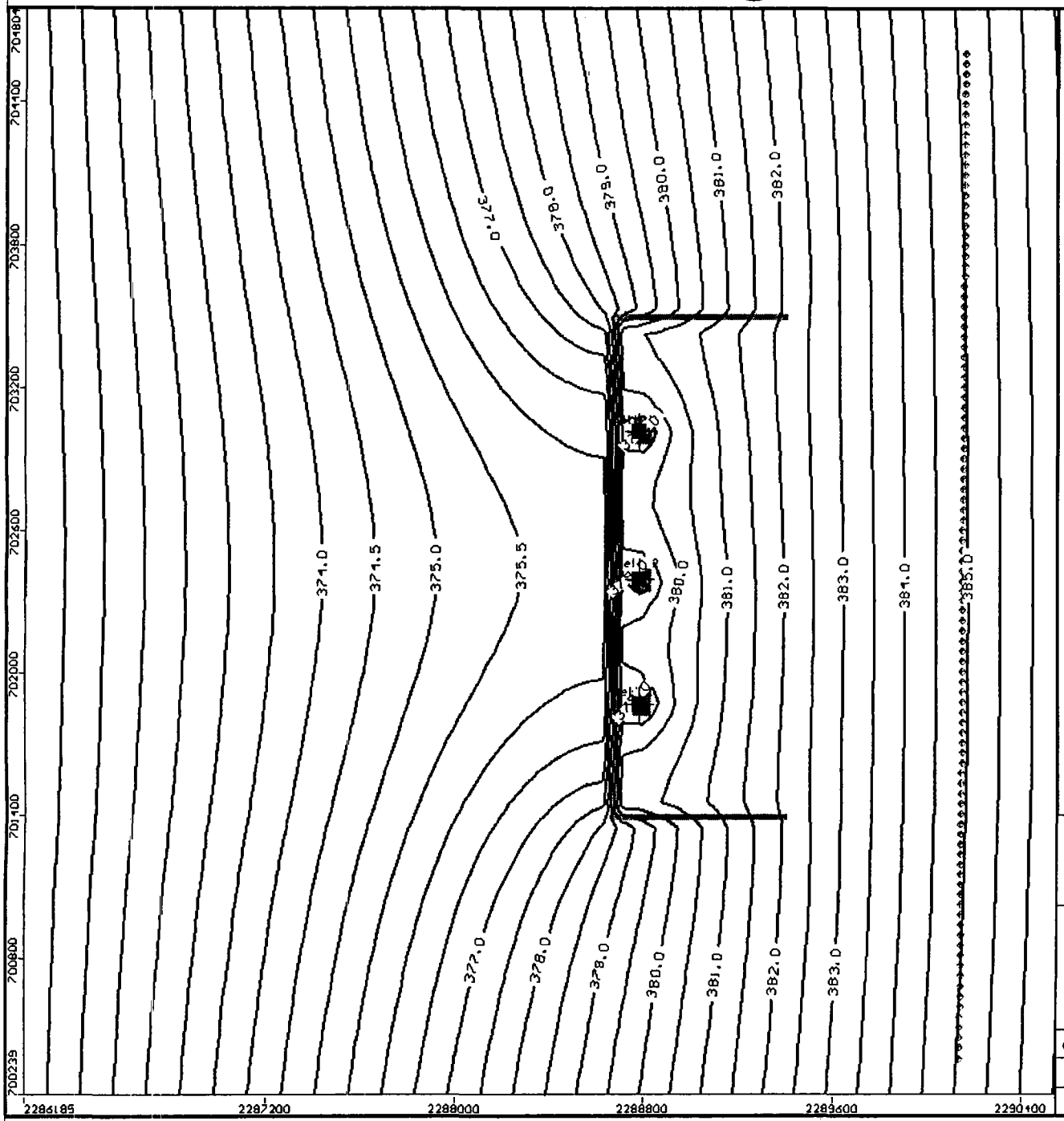
0 500

GROUNDWATER SERVICES, INC.

CASE 1: 5 FT GRADIENT
$Q_{IN} < Q_{OUT}$
(TOTAL Q = 1483 GPM)

Sauget and Cahokia, Illinois

GSI Job No.:	G-2898	Drawn by:	SKF	**Figure 8.13**
Issued:	04/1/05	Approved by:	CJN	
Scale:	As Shown	Revised:	--	



LEGEND

- Pumping Well
- 374.0 — Equipotential line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 5 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

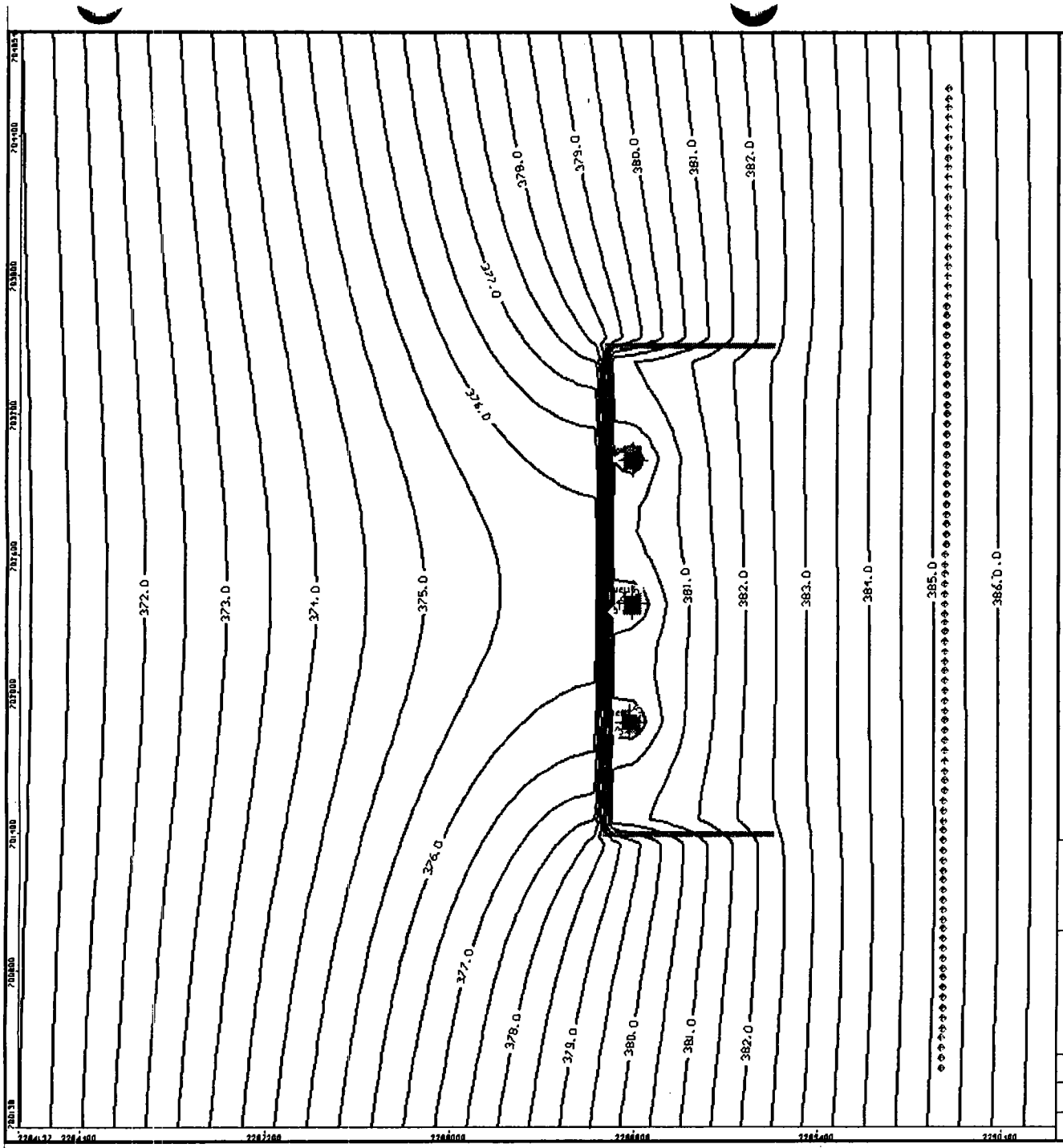
0 500

GROUNDWATER SERVICES, INC.

CASE 2: 5 FT GRADIENT
$Q_{IN} = Q_{OUT}$
(TOTAL Q = 1383 GPM)

Sauget and Cahokia, Illinois

GSI Job No.: G-2898	Drawn by: SKF	**Figure 8.14**
Issued: 04/1/05	Approved by: CJN	
Scale: As Shown	Revised: --	



N

LEGEND

- Pumping Well
- 374.0 — Equipotential line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 5 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

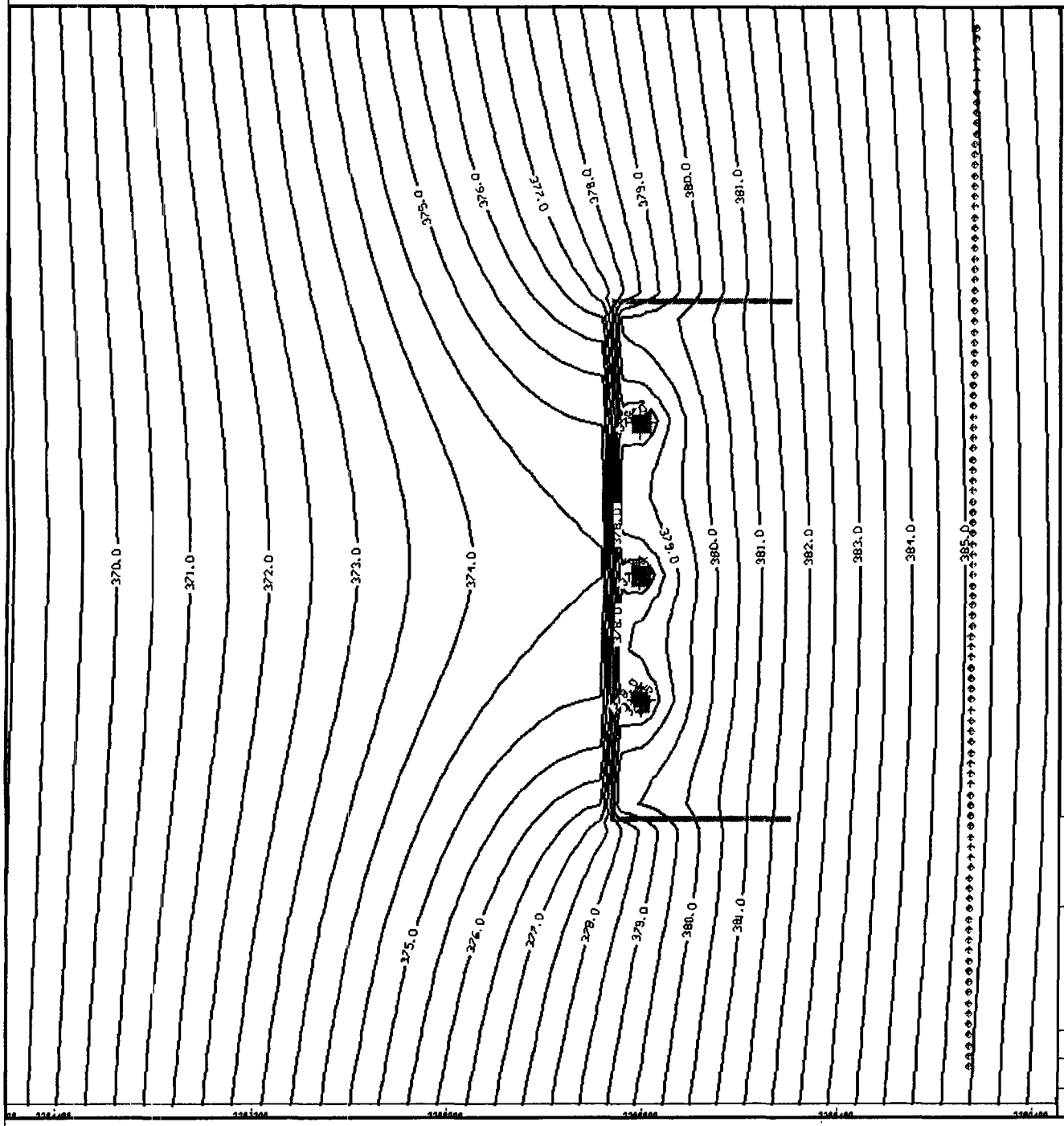
0 500

GROUNDWATER SERVICES, INC.

CASE 3: 5 FT GRADIENT
$Q_{IN} > Q_{OUT}$
(TOTAL Q = 1283 GPM)

Sauget and Cahokia, Illinois

GSI Job No.: G-2898	Drawn by: SKF	**Figure 8.15**
Issued: 04/1/05	Approved by: CJN	
Scale: As Shown	Revised: --	



N

LEGEND

- Pumping Well
- 374.0 — Equipotential line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 6 ft across U-shaped barrier obtained assuming *no pumping*, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

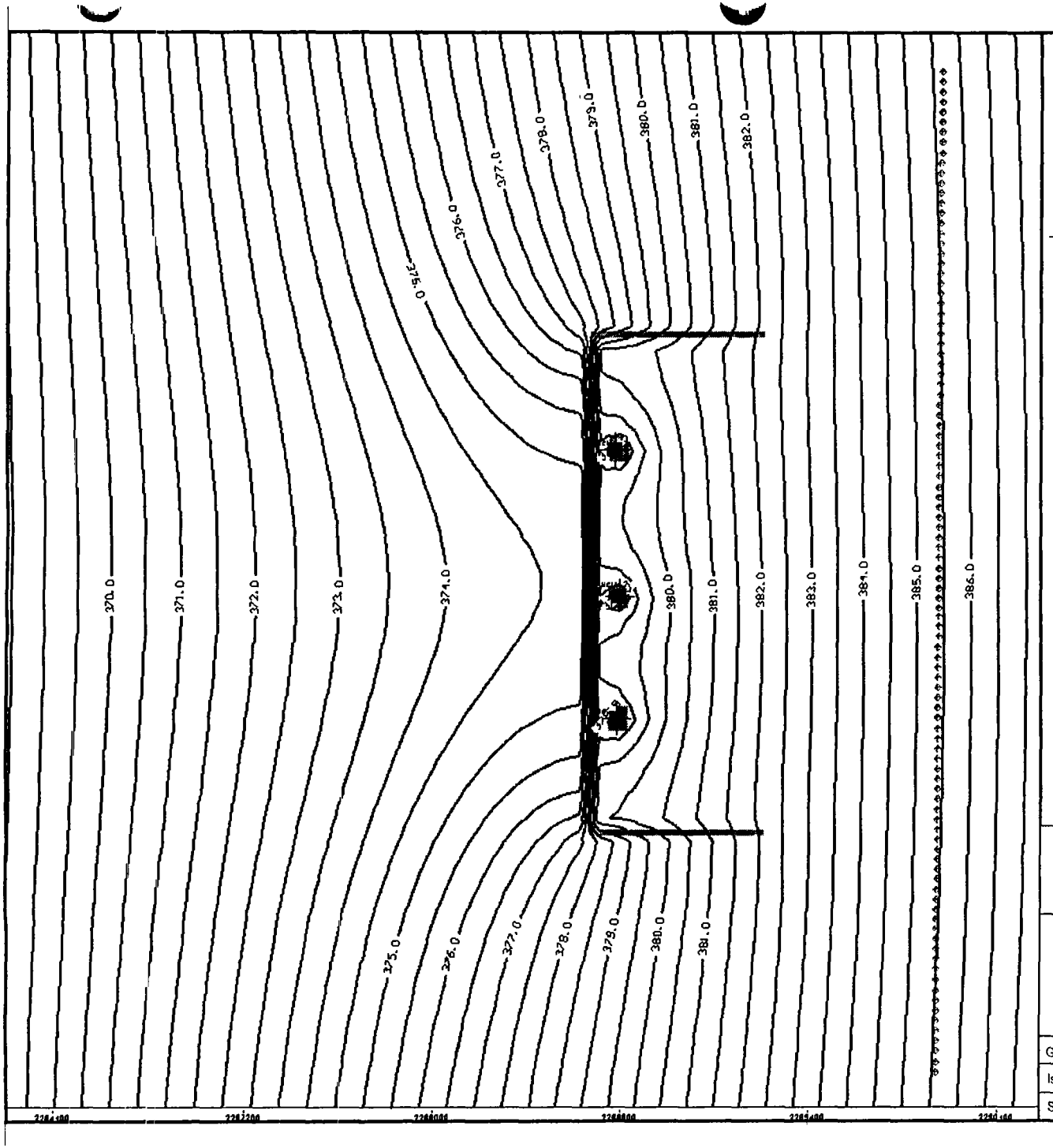
0 500

GEOUNDWATER SERVICES, INC.

CASE 1: 6 FT GRADIENT
$Q_{IN} < Q_{OUT}$
(TOTAL Q = 1735 GPM)

Sauget and Cahokia, Illinois

GSI Job No.: G-2898	Drawn by: SKF	**Figure 8.16**
Issued: 04/1/05	Approved by: CJN	
Scale: As Shown	Revised: --	



N

LEGEND

- Pumping Well
- 374.0 — Equipotential line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 6 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

0 500

GROUNDWATER SERVICES, INC.

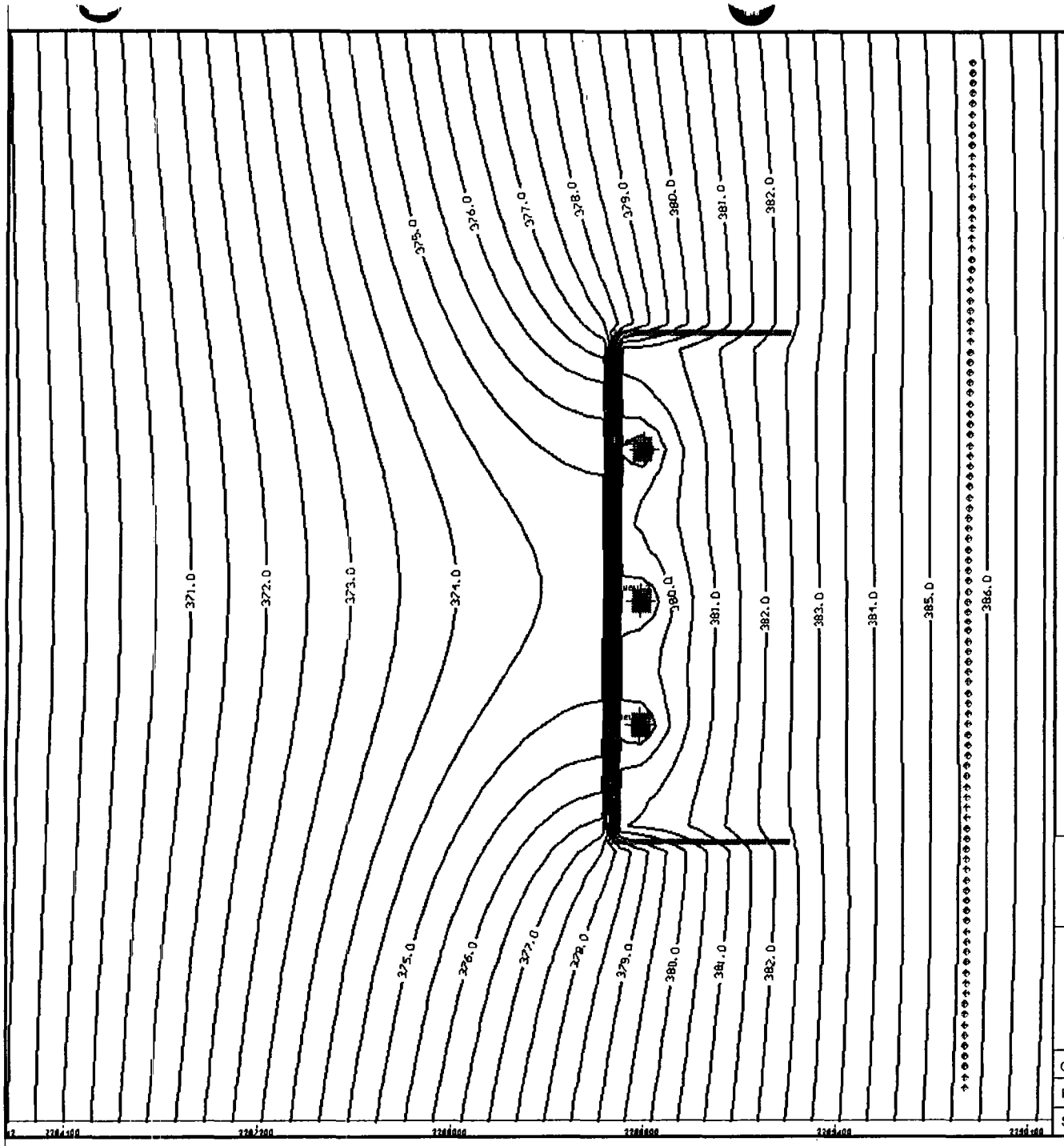
CASE 2: 6 FT GRADIENT

$Q_{IN} = Q_{OUT}$

(TOTAL Q = 1635 GPM)

Sauget and Cahokia, Illinois

GSI Job No.: G-2898	Drawn by: SKF	**Figure 8.17**
Issued: 04/1/05	Approved by: CJN	
Scale: As Shown	Revised: --	



N

LEGEND

- Pumping Well
- 374.0 — Equipotential line
- Barrier Wall
- Particle Location

NOTES:

1. Output from Visual MODFLOW model.
2. Model assumes a hydraulic conductivity of 0.137 cm/s, a hydraulic gradient of 6 ft across U-shaped barrier obtained assuming no pumping, a uniform 100 ft thick aquifer, and an approximately 3400 ft U-shaped wall.

Scale (ft)

0 500

GROUNDWATER SERVICES, INC.

CASE 3: 6 FT GRADIENT
$Q_{IN} > Q_{OUT}$
(TOTAL Q = 1535 GPM)

Sauget and Cahokia, Illinois

GSI Job No.: G-2898	Drawn by: SKF	**Figure 8.18**
Issued: 04/1/05	Approved by: CJN	
Scale: As Shown	Revised: --	